EVERY-THING BEHIND THE ENGINE

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FOR

CONDUCTORS *and* BRAKEMEN

BY

FRED McARDLE

A COMPLETE TREATISE ON THE DUTIES OF CONDUCTORS AND BRAKEMEN, QUESTIONS AND ANSWERS ON TRAIN RULES AND TRAIN ORDERS, STANDARD SIGNALS, BLOCK SIGNAL RULES, TRAIN HEATING, AIR BRAKE INSTRUCTIONS, QUESTIONS AND ANSWERS ON AIR BRAKE OPERATION (CAR EQUIPMENT).

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PREFACE

The subject matter contained in "EVERY-THING BEHIND THE ENGINE," was prepared expressly for Conductors and Brakemen, with a view of assisting them to become better qualified to fulfill their respective positions. Each subject is explained in plain, comprehensive language and can be easily understood by the inexperienced as well as by the experienced Trainmen, the instructions being confined strictly to train service. It is unlike all other books of this class, and is the only instruction book published that is devoted exclusively to the betterment of train employes. The instructions consist of a complete treatise on the duties of trainmen, examination questions and answers on Train Rules and Train Orders, Air Brake Instruction, examination questions and answers on the operation and care of Air Brakes while in service.

Changing conditions on railroads will, in the near future, demand a more thorough examination of train employes on train rules and the care of air brakes while in service, so far as they pertain to car equipment.

A knowledge of air brake appliances attached to the engine is a valuable asset to a trainman, but he

should first become familiar with the operation and parts of the equipment that he comes in contact with in his daily occupation. Trainmen who are preparing themselves for examination or promotion will, by a careful study of each subject, including the questions and answers on train rules, train orders and air brake equipment, be greatly benefited and will be better qualified to fill an advanced position.

The Author has aimed to explain each subject in a plain and comprehensive manner, in order that they may be understood by the beginners as well as by those more advanced in the service.

FRED MCARDLE.

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INSTRUCTIONS TO TRAINMEN.

PART I.

Brakemen as a rule aim to attain a higher position, namely, that of conductor, and they should bear in mind that their deportment, qualifications and attentiveness to business is the governing medium for advancement. They must consider themselves on duty at all times, except when they have permission from the trainmaster or his representative to be absent, and must be ready to answer a call at any hour of the day or night. They should report for duty not less than thirty minutes before the schedule leaving time of the train, in order that all necessary preparations for the trip may be completed and the train ready to leave on schedule time.

Reading Bulletins. Trainmen after being called will first report at the yard office and read carefully all bulletins and special instructions relating to train movements and all other notices issued for the guidance of train employes.

Bulletin Boards. Bulletin boards or bulletin books are placed at points designated by time table or by special instructions. Special instructions, new rules and general orders issued for the guidance and information of employes in the operating department are posted on bulletin boards or written in bulletin books.

Rear Brakeman. The first duty of the rear brakeman will be to ascertain if all necessary supplies for

the caboose have been secured and that they are in readiness for the trip. If at night, he will see that all signal lights are burning and are placed in their respective positions and that the tail lights or markers show red lens to the rear and green to the front and sides. The proper figures and letters must also be shown in front and back of the cupola indicator. If by day, he must see that the caboose markers are in their proper positions.

He should then inspect all couplings and air brake connections and see that all car doors are closed and fastened, that the rear angle cock of the train is closed and all other angle cocks opened, that the retaining valves are in their normal (perpendicular) position, and that all hand brakes are released.

Head Brakeman. If assigned as head brakeman, his duties would be to assist the rear brakeman in making the train inspection, and in freight service to pilot the engine from the enginehouse track, couple the engine to the train, make the air brake hose connections, look over the train while the brake system is being charged, and repair or report to the inspector all leaks found in the brake pipe or connections which may be caused by defective hose, gaskets or unions.

Brakemen's Stations. Freight Brakemen will station themselves on top of the train at such points on the line as are prescribed by the rules, and will exchange signals between the head and rear ends of train at all stations.

Book of Rules. Employes are furnished with a book of rules of the operating department in order that they may become conversant with the rules of the company and the manner in which they should be

observed. A careful study of these rules should be made, which will be the means of avoiding discussions and misinterpretations of the rules.

Watch Inspection. Every employe should be provided with a standard watch, which must be inspected by the company's official watch inspector at such times as the rules of the company may require.

Precautions. The starting signal should never be given until the trainmen and conductor first know that the train is intact and that there are no hot boxes or other defects which might make it necessary to stop the train between stations or before reaching the next stopping point.

Passing Curves. Trainmen should pay special attention to their train when passing around curves, which will enable them to detect hot boxes, broken sand boards or hangers, brake rods dragging, and other defects by closely watching the train on the inside of the curve.

Hot Boxes. When a hot box or other defect is discovered, it should not be neglected, but should be given immediate attention. The first duty of the rear brakeman or flagman is to go back with the necessary flagging supplies and protect the rear of his train, while the other members of the train crew repair the defects. A large percentage of the wrecks which are caused by burnt journals are due to negligence on the part of the train crews failing to give hot boxes immediate attention when first discovered. The practice of running hot boxes to the next regular stopping point without attention is often the cause of serious wrecks.

Removing Brasses. The removing of brasses is

usually accomplished by raising the box from the journal by means of a small jack. However, owing to the extreme weight of equipment, with capacities from 80 to 100,000 pounds loaded, the use of the small jack is in many instances impracticable. Under these circumstances the box can be raised from the journal by means of a short stake or fulcrum, which can be placed one end against the box, the opposite end resting on a tie, and moving the car slightly either forward or back, as the case may require. It is always advisable to raise the box on the opposite side of the car on the same pair of wheels, which will prevent the journal from tilting with the box. The brass and wedge on the opposite side from the one removed should also receive attention to prevent becoming misplaced when lowering the boxes.

Common Defects. Trainmen must make frequent and careful inspection of all parts of a car that are most liable to breakage. The most common and dangerous defects are broken arch bars, broken wheels, flanges, sand board hangers, all parts of the trucks and journals, defective brake rigging, broken draft rigging and couplings.

Use of Retaining Valves. When the pressure retaining valves are to be used, trainmen will turn up the required number of retainers at the top of all grades, which will hold a part of the air pressure in the brake cylinder and retain a certain amount of braking power after the brakes have been released. After reaching the foot of a grade, the retainers must be returned to their normal or perpendicular position. When only a part of the retainers are to be used, they must be operated on the head end of the train. (Re-

taining valves and their uses are explained in Part II, Air Brake Section.)

Reading Train Orders. Brakemen should understand all train orders relating to the operation of their train. The head brakeman is expected to read the train orders given the engineman, and the rear brakeman should read and understand all orders delivered to the conductor. The conductor and engineman may possibly overlook the execution of a train order which would not occur when all members of the crew understand all orders given.

Flying Switches. In placing cars on a siding so situated that they cannot be set out, and it is necessary to make a flying switch, the train should be brought to a stop at a sufficient distance from the switch. The head brakeman will go forward and see that the switch is in good working order by making an actual test, and the rear brakeman will uncouple the cars to be set out from those in the rear, being careful to release all air from the brake pipe and the auxiliary reservoirs of the cars to be set out, to prevent the brakes from setting automatically before the switch is completed. Care must be used by the brakeman to prevent a derailment in throwing the switch between the engine and the detached car.

If the switch is on a highway crossing due precautions must be taken for the protection of the public. The engine or detached cars should not be run over any unprotected highway crossing until the crossing has first been protected by a flagman.

Obstructing Crossings. Highway crossings should not be obstructed unnecessarily. After the train has been standing on a crossing for five minutes or over,

the train must be separated so that teams and pedestrians may pass. A strict observance of this rule will be the means of preventing a great deal of antagonistic legislation by city councils affecting railroad companies.

Setting Hand Brakes. When placing cars on sidings, the hand brake must always be set to prevent the car from running out of the siding onto the main track by reason of the high winds or descending grades. Air brakes should never be depended upon to hold a car when detached from the engine.

Giving Signals. Employes giving signals must station themselves where they can plainly be seen by the engineman or the person to whom the signals are given. Signals should be given clearly and plainly in order to prevent any misunderstanding. Carelessness in transmitting signals often causes damage to equipment and personal injury.

Signals Not Clearly Understood. If a signal seen by any member of a train crew is not thoroughly understood, the train must not proceed until the right to move on has been ascertained by word of mouth. Unnecessary chances of any kind must never be taken.

Lighted Red Fusees. A fusee burning red on or near the track is a signal that the train must come to a full stop, and should not proceed until the fusee is entirely burned out.

Lighted Green Fusees. When a fusee is found burning green, it indicates caution, and the train may proceed under control, expecting to find the main track blocked.

Flagging Following Trains. When the speed of a train is so reduced that it will check the speed of a fol-

lowing train before a flagman can go back the required distance, a lighted green fusce should be dropped off or two torpedoes placed on the rail, if the speed of the train will permit, to indicate caution. The engineman of such following train may proceed beyond a green signal, but only with his train under full control, prepared to stop upon the display of a danger signal.

Backing on Main Track. Before a train may be backed on the main track beyond the yard limits prescribed by rule, it must be protected by a flagman, who is required to keep the full distance of three-fourths of a mile from his train during such time as it is backing.

Trains Parting. When a train breaks in two between non-air cars while in motion, train-parted signals must be exchanged between the head and rear sections, and the separated portions be prevented from running together. The front portion must keep going until the engineer is certain that the rear portion has been brought to a stop. If the view is clear and the detached portion is not on a heavy grade, the head portion should return for the rear portion under flag protection.

The draft rigging and couplings on the rear of the last car must always be examined before backing up, to ascertain whether the drawbar or draft rigging is in a damaged condition.

When the front portion of the train consists of a number of cars, these cars should be placed on a siding when convenient, and the return made with the light engine.

Open Switches. No member of a train crew should leave a switch open for a following train unless it has

been turned over to, and is in charge of, a member of the crew of the following train. The practice of leaving switches open for section men and others to close, should not be permitted.

At Switches. At meeting or passing points of trains, the trainman acting as switch tender, after locking the switch in its proper position, should station himself at least thirty feet away from the switch, or across the track from the switch, and remain in such position until the opposing or passing train has passed the switch.

Track or Bridge Defects. If trainmen discover any defect or irregularity in track or bridges, they should immediately report the matter to the conductor, who will report it to the superintendent and will protect following and approaching trains against accidents by leaving a flagman. Never depend on a message to protect a defect in the track that is liable to cause an accident.

Rule of Safety. In case of doubt or misunderstanding, a trainmen should always adopt a course that will insure absolute safety. Chances of any kind must never be taken as they may lead to loss of life and property.

Flats and Tanks. Empty flat cars and tank cars should be placed in the rear portion of the train, immediately ahead of the caboose, providing the train is fully equipped with air brakes. On part air brake trains, there should always be a sufficient number of hand brakes accessible on the rear end of the train to control the rear section in the event the train parts.

Taking Coal or Water. When taking coal or water, the engine of a freight train consisting of over

20 cars, which are only partially equiped with air brakes, should be detached when within 100 feet of the coal chute or water tank, which will be the means of avoiding severe shocks by the use of the emergency brake when stopping at the water spout or coal dock.

Freight Car Doors. The doors of all cars in freight trains must be kept closed whether loaded or empty.

Setting Hand Brakes on Trains Having Hand and Air Brake Equipment. When the signal for brakes is given on trains consisting of air brake and non-air cars, the brakeman will begin setting the hand brakes on the non-air cars, commencing on the forward car behind the last air brake car and working toward the caboose, setting the brakes on every car, which will reduce the danger of breaking the couplings between the air brake and non-air cars.

Hose Connections. Air hose connections should be parted by hand when switching or setting out cars. If the connections are pulled apart it often results in injuring the coupling and destroying the gaskets. When the air brakes are not in use the hose should be left hanging.

Frozen Couplings. When couplings are found frozen they should be thawed with a torch before uncoupling, care being taken not to injure the gaskets.

Passenger Cars in Freight Trains. When it is necessary to handle passenger equipment in freight trains, they should always be placed at the rear end of the train, next to and ahead of the caboose.

Inspection of Running Boards and Ladders. Freight trainmen should inspect the ladders and running boards of all cars to see that they are in good condition, in addition to inspecting the running gear

and brakes, when making their train inspection, at stopping points and before starting on their run.

Approaching Stations. Both brakemen on freight trains should be in their respective positions on top of the train when approaching stations or other points where it is liable to be stopped. Signals should be exchanged between the head and rear ends of the train.

Persons Allowed on Freight Trains. The only persons allowed to ride on freight trains or to assist in switching are trainmen while on duty. Other employes or persons not in the railroad service are not permitted to ride or assist in switching without authority from the proper officer.

Track Scales. Two sets of rails placed parallel with each other are used on a section of track passing over track scales, which are used for weighing cars, the live rails being used only when the scales are in use. The dead track also passes over the scales, but it is supported in such a manner that the weight does not bear on the scale mechanism. Switches at track scales when the scales are not in use must be left so that the engine and cars will use the dead rails while passing over the scales.

Use of the Bleed Cock. If the engineman cannot release the air brakes in the usual manner, they can be released by the trainmen opening the bleed cock of the auxiliary reservoirs and holding it open until the piston starts to return into the cylinder.

Conductor's Valve. The conductor's valve should be used only in case of an emergency, and when used it should be left open until the train has been brought to a stop or the danger is past.

Replacing Defective Hose. New hose should be used to replace those which may become defective. If there is no extra hose in the caboose, take the hose from the rear end of the rear air brake car of the train. After the broken hose has been replaced, the brakes to the rear of the broken hose may then be released by the engineman. When a hose is taken from the rear car to replace a defective one it should be reported on arrival at the terminal.

Defective Equipment. Defective air brake or air signal equipment should be carded and reported on arrival at the terminal.

Blocking Car Wheels. When cars with defective hand brakes, or cars on which the brakes cannot be operated, are set on a siding, they should be coupled to other cars, if possible, and the wheels blocked. Every precaution should be taken to prevent possibility of accident by cars without brakes running out and fouling the main track.

Detaching Engine. The practice of detaching the engine from the train while in motion and allowing the latter to follow by its own momentum is a dangerous one, and should never be done, as it may not be possible to keep the detached cars under control.

Station Switching. When doing station switching, brakemen are required to do the work in accordance with the switch list furnished by the station agent, and under the direction of the conductor. Cars should be handled carefully as there is danger of damage to car and contents when handled roughly.

Entering Team Tracks. Before coupling onto cars on house or team tracks, trainmen must see that no obstruction such as elevator chutes or skids are in

use, and that men and teams engaged in loading or unloading cars are not in danger.

TRAIN PROTECTION.

When a train stops between stations or at stations where flagging is required, it is the duty of the flagman to go back immediately with the necessary flagging supplies and protect the rear of the train. He should never wait for instructions from the conductor, but should give this most important duty his immediate attention. (Many of the railroads have their own special rules concerning the details of train protection.)

The flagman should provide himself with not less than two torpedoes and a red flag by day, and with both a red and a white light and two red fusees by night. At night he should place a lighted red fusee in the center of the track 500 feet behind the rear of the train, and will then proceed either by day or night to a point not less than 3-4 mile distant from the rear of his train (24 telegraph poles), until he reaches a point where a danger signal can be seen for a distance of not less than 1-4 mile (8 telegraph poles) by the engineman of an approaching train. (40 telegraph poles to the mile are being used on some roads instead of 32, the usual number. Flagmen will take this into consideration and go back 30 and 10 poles respectively instead of 24 and 8 poles.) He will then place one torpedo on the rail of engineman's side of the track, and will remain in this position until the following train has arrived, or until he is recalled. If recalled and there is no approaching train in sight, or no first class train is due within ten minutes, he will place a second

torpedo on the rail 200 feet nearer his train than the first torpedo, and return to his train with all possible speed, always bearing in mind that the time at which the flagman is returning to his train is a period of the greatest danger. In foggy or stormy weather, or when there is a descending grade toward his train, a flagman should go a greater distance from his train in order to insure absolute safety. When necessary to protect the head end of the train, it will be done in the same manner.

Conductor in Charge. The conductor is in charge of the train and is held responsible for its operation. All other members of the crew are subject to his orders, except when such orders conflict with the rules of the company, or when life or property is in danger.

TIME TABLE INDICATIONS.

"s" indicates regular stop.

"f" indicates train stops to receive or discharge passengers or freight.

"¶" stop for meals.

"l" leaving time.

"a" arriving time.

"D" day telegraph office.

"N" day and night telegraph office.

"W" water station.

"X" railroad crossing.

"O" track scales.

"C" coaling station.

"T" turntable.

"Y" wye.

PASSENGER BRAKEMEN.

Qualifying for Baggageman. Passenger brakemen are usually promoted to the position of train baggageman and they should familiarize themselves with the duties in connection with that position, in order that they may be able to relieve the baggageman when so instructed.

Reporting for Duty. A passenger brakeman should report for duty at least thirty minutes before it is due to leave its initial terminal, in order that his train may be ready for the reception of passengers a reasonable length of time before it is due to leave. His first duties are to see that the doors are unlocked and that the train is properly cleaned and ready for passengers. He will then inspect the heating system to see that it is in good order and that the train is properly heated.

Adjustment of Window Shades and Car Seats. The window shades should be drawn down on the sunny side of the train when the weather conditions require it, and the car seats should be turned so that passengers will face in the same direction as that in which the train is running.

Water Coolers. The brakeman must see that the water coolers are well supplied with ice and fresh water, and that drinking cups are provided.

Toilet Rooms. Toilet room doors must be locked and kept locked until the train has started from the terminal, and before the train reaches a terminal, or a passenger station, the toilet rooms must be again relocked.

Announcing Stations. Before the train leaves the terminal, brakemen should clearly announce in each car, the stations at which the train stops and its connections. When leaving intermediate stations the brakemen will pass through each car from front to rear, and when about one-third of the distance from the head end of the car, he will announce in a clear voice the name of the next station at which the train will stop, the announcement to be repeated when about one-third the distance from the rear of the car. Stops for meals will be announced in the same manner. If the train stops at a railroad crossing located at or near a station at which the train is scheduled to stop, it will be announced: "Next stop will be a crossing stop, not a station stop."

Announcements in Parlor and Sleeping Cars. The announcement of stations and stops in parlor and sleeping cars will be made by the conductor or porter of such cars.

Passing Through Dining and Sleeping Cars. Passenger train employes should remove their caps when passing through dining cars while meals are being served.

When passing through sleeping cars after the passengers have retired, they should move quietly and conceal their lanterns. If it is necessary for them to engage in conversation in sleepers, it should be done in a low tone of voice.

Gas Lights. If gas is used for train lighting, the brakeman should see that all gas cocks are closed when the lights are not in service. When lights are required, the main valve should be given about one-half its opening, and each lamp then lighted separately,

the lamp valve to be turned on full, closing the globe of each lamp before the next one is opened for lighting. When all lamps in the car have been lighted, the lights should be reduced at the main valve to about one-half flame for about five minutes, in order that the burners may become heated. The main valve should then be given its full opening. Printed instructions covering the use of Pintach gas will be found near the main valve and should be given careful study.

Coal Oil Lamps. If coal oil lamps are used, the brakeman should see that they are in good working order before lighting, and kept in good condition during the trip.

Turning Down Lights. On night trains the main gas supply valve must be turned partly off and all lights reduced to one-half flame, or a part of the burners extinguished at the time prescribed by the rules.

Extinguishing Lights. At daybreak all lights must be extinguished. If gas lights are used, the gas valves on each lamp and the main valve must be closed.

Approaching Tunnels. When tunnels of sufficient length require train lighting, the brakeman should close all doors, windows and ventilators, and light at least one lamp in each end of the coach. The flagman should also display both night signals on the rear end of the train.

Inspection of Couplings. Passenger brakemen should see that all air brake and signal hose are coupled and angle cocks cut in, and that the hand brakes are in good working order. They should also see that all stay chains are coupled before the departure of the train.

Tail Hose. A tail hose is a section of hose about five feet in length equipped with a brake pipe hose coupler on one end and an air whistle and discharge valve on the opposite end. The hose is coupled to the air hose at the rear end of the rear car, the whistle and discharge valve is fastened to the platform railing where it can be easily reached by the trainman when operating the discharge valve or air whistle. The purpose of the air whistle is to warn the public when the train is backing over public crossings or into passenger stations. The discharge valve is used to apply the brakes from the rear of the train when backing. (The use of the tail hose is explained in Part II, air brake section.)

Testing the Air Signal Line. The air signal whistle must be tested in each car by the whistle cord, in order to know that all connections are properly made and that the signal system is in good working order.

Making Up Passenger Trains. At points where there is no switching service it is the duty of the brakeman and baggageman to do all necessary switching in making up and putting away the train. It is also the duty of the brakeman to couple the engine to the train, make all hose connections, and test the brakes at points where there is no inspector assigned to this work.

Neatness in Appearance. Passenger employes should always be neat in appearance, their linen should never be in a soiled condition, they should be clean shaven each day, their shoes shined and uniforms kept clean and neatly pressed.

Receiving Passengers. When the train is ready for the reception of passengers, the brakeman should take a position at the car steps and render all necessary assistance to passengers who are boarding the train.

Mannerly to Passengers. Passenger employes should always be polite and courteous toward the traveling public, and should pay particular attention to the comfort and safety of passengers, special attention should be given to women and children who are unattended, and to all others who are unable to care for themselves. They should assist them when getting on and off the train and secure seats for them when necessary.

Baggage in Coaches. Passengers must not be permitted to put their feet on the opposite seat to that in which they are sitting, or use the coach aisles for the storage of baggage, causing the passageway to become blocked. All baggage carried into coaches should be placed under the car seats or in the racks provided for that purpose. Train employes must exercise all possible courtesy when enforcing the above rules.

Safety of Passengers. Train employes must keep passengers off the car platforms and prevent them from getting on or off the train while in motion, or from incurring other risks, or violating rules provided for their safety.

Preserving Order. All train employes must assist in preserving order upon the train, and when necessary they should call the passengers' attention to the rules of the company in a quiet gentlemanly manner, without attracting unnecessary attention, but should

insist firmly upon compliance with the rules, avoiding altercation or dispute if possible.

Familiarity With Passengers. Trainmen should avoid all familiarity with passengers and must not engage in conversation with them other than to answer all questions and give such information as requested in the proper discharge of their duties.

Reading on Duty. Train employes are prohibited from reading while on duty, and should not engage in conversation with other members of the train crew, except in matters pertaining to their duties, nor allow their attention to be diverted from their duties in any way.

Passing Through Coaches. The brakeman must pass through the cars at frequent intervals to see that the wants of the passengers are attended to, and that order is preserved. When leaving stations, he should observe whether any person is holding to the hand rails or steps outside of the vestibule.

Turning Coach Seats. All coach seats must be turned in the direction in which the train is moving, except when it is permissable to allow passengers to use double seats.

Deportment at Stations. When in attendance upon a train at stations the brakeman should maintain an erect position near the steps of the car, except when assisting passengers. He should not leave the car or stroll about the station platform. Conversation with station employes and others should be avoided, except when relating to railroad business concerning his train.

Ejecting Passengers. When a brakeman is called upon to assist in ejecting passengers from the train,

he should avoid unnecessary force or anger, taking only such action as is necessary to effect the ejection, and to protect himself and other members of the crew.

At Stations. Before allowing passengers to enter the cars, the brakeman should see that passengers who wish to leave the train are out before others are allowed to board the train.

Running Past Stations. When a train runs past a station, passengers must be prevented from attempting to alight until the train has backed to the station platform and come to a full stop.

Adding Cars to Train. When cars are added to the train enroute, and no inspectors are at hand, the brakeman will assist the conductor in making an inspection and in testing the air brakes before starting.

Safety in Switching Coaches. When coaches containing passengers are switched, all air brake must be cut in and in use. The safety of passengers must be the first consideration of trainmen.

Applying Salt to Platforms. During the winter months salt should be applied to the platforms of passenger coaches whenever they become covered with snow or ice, which will prevent them from becoming slippery and dangerous.

Coaches Placed on Siding. When coaches are set out on sidings which are not terminals, the brakeman must close and lock all doors and windows and see that the hand brakes are set and the wheels blocked.

Passing Stations. The rear brakeman or flagman on passenger trains should always station himself on the rear platform of the train while passing through stations, for the purpose of observing any signals

which may be given to his train by any of the station employes.

Passenger Train Inspection. A passenger brakeman should make an inspection of the brake equipment, couplings, hose connections and signal appliances at every opportunity.

Gambling or Soliciting Alms. Gambling by passengers or the soliciting of alms on passenger trains should not be allowed.

Coach Doors Not to Be Fastened. When a train is in motion the doors of coaches must remain unlocked, and the open space on the rear end of the last car between the railings be protected with a tail chain.

TRAIN HEATING.

BAKER HEATERS.

The Baker Heater is an appliance for heating passenger cars by means of hot water. It consists of a furnace in the form of a heating stove placed at one end of the car. A coil of piping passes through the furnace and is connected with the expansion drum, from which radiating pipes are run to the various parts of the car and return to the furnace. When the water becomes heated in the furnace coil, it starts to circulate and then passes to the drum, thence through the radiating pipes in the car, and returns to the furnace coil, where it is reheated and again passes into the radiating pipes, the circulation of the water throughout the piping system being aided by the compressed air in the expansion drum.

How the Air is Compressed. When the water in the coil becomes heated, steam is generated, which expands, compressing the air contained in the expansion drum.

Salted Water Used. Salt is added to the water used for filling the heater, in order to prevent the water from becoming foul, and also to prevent it from freezing during cold weather, when the heater is not in use. Water that has been sufficiently salted for use in the Baker Heater will not freeze until a very low temperature has been attained, while fresh water will freeze at a temperature of 32 degrees above zero. It is not necessary to drain the water from the heater

system, except when necessary to make repairs or the car is taken out of service.

Expansion Drum. The expansion drum, which is a part of the heating system, is placed near the top of the car, directly over the furnace, and at the highest point accessible, in order that the air which is forced from the pipes will rise and gather in the drum, becoming compressed and aiding the circulation, as the temperature of the water increases.

Safety Vent. If the safety vent, which is located on the upper side of the expansion drum, is blown out, which may be caused by an overheated furnace or restricted circulation, it would result in the loss of more or less water, which must be replaced before the system is again put in operation. The fire in the furnace should be put out at once in order to prevent damage to the coil of pipes passing through the furnace.

Testing Height of Water. To ascertain the amount of water in the heater system, the combination cock at one end of the expansion drum should be opened, and if there is a sufficient amount of water in the heater it will run out of the waste pipe. This test should be made when the fire is low and there is no pressure in the pipes.

Doors Should Be Closed. The feed door and the ash pit door should be kept closed and fastened except when the fire is being started or replenished.

To Secure Best Results. The best results are obtained by keeping the water at the proper height, and solid throughout the pipes. A slow, steady fire is also essential.

STEAM HEATING.

Source of Steam Supply. The steam used in the train heating system is supplied by the locomotive boiler, the pressure in the heating system being controlled by a reducing valve in the locomotive cab.

Tracing the Steam Through the System. The steam passes from the boiler through the reducing valve to the steam heat line, which runs underneath the body of each car, the connections between the cars being made by means of steam hose and couplings. The steam pipes which run throughout the inside of the car are connected to the steam line by means of a short section of pipe and a valve which may be operated from either the inside or outside of the car.

Heating the Train. To heat the train, the train pipe valves of all cars should be opened except the valve on the rear of the last car, which should be closed. All floor valves should also be closed, except those in the rear car. Steam pressure of at least 60 pounds should then be turned on at the engine and allowed to pass through the steam line, forcing out the cold air and condensation until dry steam appears at the valve of the rear car, after which the valve should be nearly closed, allowing a small quantity of steam to escape during the entire time that the heating system is in use. The floor valves should then be opened, commencing at the rear car and working forward. When all the floor valves have been opened and all radiating pipes are filled, the engineman should be notified to reduce the steam pressure in the train pipe to meet the weather conditions.

Regulating the Heat. To regulate the heat, the

brakeman should operate one or both of the steam valves under the car seats. These valves should be either closed tightly or given at least one-half their opening. When operating one valve, the valve on the windward side of the train should be used.

Shutting Off Heat. To cool the radiators in an overheated car, the hand bleeder valve should be opened fully and left open. The inlet steam valve should then be closed. In freezing weather the inlet valve should not be left closed longer than ten minutes, but should be reopened and closed at frequent intervals, and the water from condensation allowed to escape through the trap or bleeder to prevent freezing.

Setting Out Cars. When a car is set on a siding, the steam radiators and pipes must be thoroughly blown out before the steam supply is cut off ahead of the cars to be set out, allowing the steam to blow through all inlet and hand trap valves, and the rear train pipe valve opened. When two miles from the point at which the cars are to be detached, the train pipe valve on the car ahead of the one to be set out should then be closed. When the entire train is to be detached from the engine, the engineman should be signaled in the usual manner to shut off the steam heat after the system has been thoroughly blown out.

Coupling Steam Hose. When coupling the steam hose connections, the coupler bodies should be raised up evenly so that both sides will lock at the same time, and the gaskets come up fairly against one another. When uncoupling the steam hose, the coupler bodies should be pulled straight up in the center.

DUTIES OF CONDUCTORS.

Conductors would do well to remember that they were once brakemen themselves, and always bear in mind that a kind word and genial manner will often secure better results than a sullen appearance and gruffly spoken words, and makes friends with their fellow employes and the public generally, in addition to elevating them in the estimation of their employers. This rule is especially applicable to new men in the service.

Responsibility. Conductors are held responsible for the safe management of their train and for the strict performance of duty on the part of all other employes on the train.

Authority. Conductors are clothed by law with power of sheriffs to quell disturbances or protect property or persons upon their trains. If the offense is such that it becomes necessary to make arrests upon such occasions they should secure the offenders and deliver them to the sheriff or police at the first station where such officers may be found, aiming to keep the offender within the state where the offense was committed.

Track and Wire Defects. When a conductor discovers defects in the track, bridges or culverts which would be likely to cause an accident to a following train, he should not rely wholly upon the telegraph to notify other trains, but should leave a flagman and notify the nearest station foreman.

When notified of a defect in the telegraph line, he

should instruct the brakeman to watch for the same, and when found report its character and location to the telegraph operator at the next office.

FREIGHT CONDUCTORS.

Before Leaving Terminals. Before leaving the initial station on any division a conductor must report to the train dispatcher for orders, giving the number of the engine and the name of the engineman, and on roads where the rules so prescribe he must furnish a detailed report of the cars in the train which must include the contents and the destination of each car. If there are no orders for his train he must receive a clearance properly dated, addressed and signed, and must see that the engineman receives a copy. He must also see that his train is made up as required by rule, and that all couplings and air brake connections are inspected.

He must know that the necessary air brake tests are made and that all car doors are closed and securely fastened; also see as far as possible that cars are properly loaded, and that the ladders, hand holds, running boards and brake wheels are in good order; that all air brake cars are placed ahead and in use and that all flat cars and gondolas are placed in the rear of the train, just ahead of the caboose.

Bulletins and Special Orders. Conductors must read and understand all special orders and bulletins posted at the initial terminal; in addition he must read all bulletins and special orders posted on bulletin boards at other stations enroute when it is possible for him to do so. He will be held responsible with

the engineman for the observance of all special orders and bulletins pertaining to train movements. The engineman of his train must also be advised of all new special orders and bulletins posted at intermediate stations that may in any way concern the engineman or the operation of the train.

If the train has more than one engine, each engineman must be notified of all special orders and bulletins, or if the engine is in charge of a pilot both the pilot and the engineman must be notified.

Train Register. A conductor must personally register his train at all registry stations unless especially instructed otherwise. He should bear in mind the fact that the register is depended upon to govern the rights and movements of other trains leaving terminals and passing registering points enroute. All entries should be made clearly and legibly.

He must also make every effort consistent with the rules to move his train with regularity and as nearly on time as possible. Any lack of co-operation on the part of other employes should be reported to the proper official.

Leaving Terminals Without Full Crew. A train should never be started from its initial station without a full crew, except by direction of the superintendent or other authorized official. If any member of the train or engine crew is disabled by illness or injury, or leaves the train while on the road, a detailed report must be made to the proper official by telegraph, and unless the remaining members of the crew are able to handle the train safely he should await instructions before proceeding.

Train Orders. At points where train order sig-

nals are displayed, or where orders are required for the further movement of the train, the conductor must immediately report to the telegraph office.

If a train is detained for orders at a telegraph office where the agent or operator is absent, the conductor must look for the address of such employe, call him, and report for orders.

If, upon arrival at a meeting or passing point, whether fixed by schedule or special orders, and the train to be met or passed has not arrived, the conductor must report at the telegraph office for orders.

Stopping For Meals. A train should not stop for meals without knowing that such action is satisfactory to the chief train dispatcher, except when provided for by schedule.

Delays to Train. In cases of delay to his train that is likely to affect the movement of other trains, a conductor must report promptly to the train dispatcher, if possible, giving the reasons for the delay and its probable duration.

Relieved During the Trip. If a conductor is relieved during a trip all unfulfilled orders must be delivered to the relieving conductor. Before proceeding, the relieving conductor must compare his orders with those of the engineman. If no orders are delivered to the relieving conductor he must not allow the train to proceed until assured by both the relieved conductor and the engineman that there are no train orders in effect.

Train Inspection. A conductor must inspect the running gear, brake equipment and draft rigging of his train as often and as closely as possible while on the road, and require his brakemen to assist in such

inspection. Any defects discovered should be remedied as far as possible, and any cars that are in an unsafe condition to run should be set out.

Setting Out Cars. When cars are set out on a siding the hand brakes on the cars set out must be securely applied; never depend on the air brakes to hold a car when detached from the engine. If the brakes are defective the car wheels must be blocked, and if a derailing switch is provided, such switch must be set so as to prevent any cars from running out and obstructing the main track. Cars on a siding should always be coupled when practicable.

When it is necessary to set out cars at other than the regular point of delivery, or when cars are left for the movement of which orders have been issued, the conductor must notify the agent or yard master of such action and the reason therefor, and in addition make any other reports prescribed by the rules of the company.

Running or flying switches must never be made if they can be avoided, and, when it is necessary to do so, movements must be made with all the care necessary to prevent accidents.

Transmitting Signals. A conductor must see that the hand and lamp signals given by members of his crew are carefully and accurately given and that whistle signals are accurately sounded. When switching is being done he must also see that both the engineman and fireman are on the engine so that signals can be observed from both sides of the train.

Obstructing Highway Crossings. A conductor must see that his train does not obstruct street and highway crossings for more than the prescribed time

and that all ordinances of cities and villages limiting such obstructions, and regulating the rate of speed over street crossings, are fully complied with. When trains are cut at street crossings the cars should clear the entire width of the street.

Protecting Against Accidents. In cases of heavy rain or high water the conductor must see that caution is exercised in approaching bridges, culverts and other parts of the road bed likely to be damaged, and must be assured of their safe condition before allowing his train to pass over them.

When a conductor has reason to believe that any part of the track or road bed over which his train has passed is in an unsafe condition, he must stop the train and make an investigation. If unsafe conditions exist and there are no trackmen available or other means of protection, he must leave a flagman with the proper signals to protect following trains, and in addition must give notice to all opposing trains that are met until he is certain that the dangerous point is fully protected by notification and trackmen. He should also stop at the nearest telegraph office and report by wire the nature of the defective track and the action taken to the proper official. Conductors should never depend on a message to protect a train against accident when defective track exists, without additional protection by flag.

Train Accidents. In case of accident, the conductor should immediately report by telegraph the train number, engine number, engineman's name, time and place of the accident and whether it occurred on the main track or a siding. He should state what tracks are obstructed, the cause of the accident, speed of

the train at the time of the accident, the distance the train or cars run after the derailment, whether a wreck train is required, and, if so, from which end of the wreck the wrecker can work to the best advantage. He should state whether an engine can be used to advantage at the opposite end of the train from the wrecker; whether the wreck can be cleared with the assistance of an engine and without the wreck train; whether the engine is disabled, and if off the track, giving the position; the number of cars in the train; loads and empties; the number of loads and empties off the track; the number of cars ahead of and behind the wrecked cars; the number of air brakes in service at the time of the accident; the approximate length of time required to clear the track so that trains can pass; whether the accident happened between switches so that trains can pass; whether a temporary track can be built around the wreck; whether passengers can be transferred around the wreck; what material is required to repair the track; the number of sets of trucks needed; the initials, numbers, contents and points of destination; the nature of damage to the engine and each car separately; the class of equipment required to make transfer; the number of personal injuries, if any; the full names and positions at the time of the accident of all persons injured, and the weather conditions(whether clear, foggy, raining, snowing, moonlight or dark). In addition, any other information should be given that will be of assistance to the superintendent in determining whether it will be necessary to arrange for the detouring of trains. It is essential that full information be given concerning the supplies necessary to put the track in

proper condition after the wreck is cleared. This information should be telegraphed to the superintendent's office as soon as possible after the occurrence of the wreck. If passenger, time-freight or live stock trains are due within a short time, immediate notice must be given to headquarters in order that such trains may be stopped at a junction or detouring point. This notice should be given before making a detailed report of the accident.

In case of accident to a train at points where there are no means of communicating with the superintendent or chief train dispatcher, a conductor may command the services of other engines and the members of other crews, if required.

Personal Injury. If the train is involved in any accident from which claims for personal injury may result, the conductor should obtain the names and addresses of all persons involved, and a statement from each as to whether any personal injury has been sustained. A complete report covering these matters should be made to the proper official. In case of personal injury, the nearest company's surgeon should be called, if one is available; if not, the nearest local surgeon should be called. Any injured person, either employe or passenger, should not be neglected, but should be cared for and accompanied to the nearest company's surgeon by some reliable employe of the company. The disposition of injured persons should be included in the report.

In case of death occurring on the train from accident or otherwise, or the killing of any person on the track by the train or engine, the conductor must see that the body receives proper care, that it is removed

as soon as possible to the proper place and left in charge of a public official or an agent of the company. The carrying of a corpse from one county to another should be avoided is possible.

Responsible For Security of Freight. A freight conductor is responsible for the security of all freight carried on his train while in his charge, and for its delivery with the necessary way-bills or manifests at its destination or at terminals.

Cars in An Unsafe Condition. A conductor must not take cars which in his judgment are unsafe to run, by reason of their being loaded beyond their capacity, or not within the clearance rules and the load properly distributed and secured. In such cases he should notify the yard master or station agent of his refusal and the reasons therefor.

When a car bears a defect card or "bad order" marks, it must be assumed that such car is defective until assurance is had to the contrary, and such marks are erased or card detached by the car inspector or other authorized person.

When adding cars to the train at intermediate stations, the same precautions should be observed in inspecting cars for defects before adding them to the train as before starting from terminals or junctions.

At points where no car repairers or inspectors are stationed, a conductor must, with the assistance of his trainmen, thoroughly inspect all cars offered and be assured of their safe condition before adding them to the train.

Explosives. Cars containing explosives should be placed at least five cars from either end of the train whenever practicable.

Car Records. A conductor must keep a record of all cars handled in his train. He must enter in his Train Book the numbers and initials of all cars, from what points billed, the points at which they were taken into the train and to what points hauled, the contents of each car, or if empty it should be so stated, a record of all seals applied, the number of the engine and the date. Record books when filled must be turned in to the trainmaster or other prescribed official who will file them for future reference.

Waybills. A conductor must have a waybill, manifest or memo, waybill from the yard master or station agent for every car, loaded or empty, in his train, and the numbers and initials entered therein must correspond in every particular with those on the car. A less than car lot shipment will not be moved without a waybill being furnished, the marks on the waybill corresponding with those on the shipment.

If the initials or numbers entered on a waybill do not correspond with those on the car or in case any alteration is made on a waybill, in the absence of a notation on such waybill, showing by what authority such correction is made, a conductor must communicate with the chief train dispatcher, or other prescribed official and obtain the necessary authority to move the car on such waybill.

Carrying Passengers on Freight Trains. Passengers must not be permitted to ride on freight trains not designated to carry passengers. Officials of the company, track, bridge and building supervisors, line repairers and such other employes whose duties require it may be carried without special authority for so doing. Company employes must ride in the caboose unless their presence is required elsewhere.

Position on the Train. A conductor must maintain a position on his train that will give him a full view of the train and enable him to see whether the members of the train crew are in their proper positions and fulfilling their duties. Brakemen should be stationed at such points on the train as will enable them to pass signals from any part of the train to the enginemen and will exchange signals when passing through all stations and past interlocking plants.

Handling Live Stock. In handling cars of live stock, a conductor must see that the utmost care is taken in handling such cars to avoid injury. The person in charge of live stock should be given an opportunity to examine and care for it while in transit. If the stock gets down, the train crew must render all possible assistance to the attendant, and if they cannot be gotten up the car containing such equipment should be set off at any station requested by the attendant, placing such car at the stock chute. A report of the circumstances should be made by wire.

When the contract of shipment provides that the shipper of live stock shall send an attendant to care for it, and such attendant is inclined to abandon the stock in transit and before reaching its destination, a conductor must not assent to the wishes of the attendant, but must notify him that the company will not undertake to care for such stock and will assume no responsibility.

If no attendant is in charge and the stock gets down, the conductor, with the assistance of the train crew, must make every possible effort to get the stock up.

Protecting the Train. A conductor must always

be careful to prevent any action that may result in an accident to his or other trains, and should bear in mind the fact that many of the most serious accidents to trains have been caused by a lack of proper flag protection. No other duties of a conductor or trainman should interfere with this most important duty of protecting his train, and he should always insist on a flagman acting promptly and in strict accordance with the rules.

When a train fails to make its schedule time or for any other reason there is a possibility of his train being overtaken by another, a conductor must see that his train is slowed sufficient to permit of the flagman getting off and going back to protect the train in the manner prescribed by the rules.

PASSENGER SERVICE.

Reporting For Duty. A conductor in passenger service should report for duty at least thirty minutes before the leaving time of his train, and must see that the trainmen are on hand; that the train is properly made up; that it has been inspected; that the cars are properly cleaned, ventilated, heated, lighted, provided with water, ice and fuel; that the seats are turned so that passengers will be seated in the direction in which the train is to be moved; that the window shades are drawn on the sunny side of the cars when weather conditions warrant this action, and the train ready for the reception of passengers.

He should also witness the tests of the air brake, steam heat and air signal appliances, and assure himself that they are connected and working properly

throughout the train and that the side doors of vestibule cars are kept closed while the train is in motion.

As soon as his train is ready for passengers he must see that the trainmen are stationed where they can best direct and assist passengers. At intermediate stations, he must remain upon the station platform and give constant attention to his train and passengers, except when it is necessary to enter such stations for orders, to register his train, or examine the train register, bulletin board or special order book. He must see that his brakemen maintain an erect attitude near the steps of the cars at which they are stationed, except when they are assisting passengers, and that they avoid conversation with station employes or others, except with relation to the train and the giving of proper information, and that they do not lean against the cars or lounge or stroll about the station platform.

Starting Signal. A conductor must not give the starting signal at inspecting stations until notice is received from the car inspectors that their work is finished.

Running Past Stopping Point. If a train runs past a stopping point, thus making it necessary to back, the conductor, before giving the signal to back, must see that passengers are warned not to alight until the train is backed to the proper stopping point. Passengers must be prevented from getting on or off the train while it is in motion.

Passing Through Train. The conductor should pass through the entire train as often as necessary for the purpose of attending to the wants of passengers, preserving order and seeing that the trainmen are properly performing their duties. Without being un-

duly officious he should contribute as far as possible to the comfort and convenience of passengers, giving particular attention to women and children who are unattended and to all persons who are ill, infirm, inexperienced, or in any other way unable to care for themselves.

Seating Passengers. Passengers should be provided with seats as far as possible and no one should be allowed to occupy more than a single seat to the exclusion of others when there are an insufficient number of seats in the coaches. When there are vacant seats in parlor or sleeping cars in regular service, passengers who cannot be given seats in the coaches may be seated therein, and the proper arrangements made with the conductor of such parlor or sleeping car. Such seats must, however, be surrendered as soon as there is room in the coaches or whenever such seats are required for regular use. Seats in sleeping cars cannot be assigned or occupied at night after the regular passengers have retired. In case the train has not a sufficient number of cars to accommodate all passengers, a report must be made to the chief train dispatcher, so that proper arrangements for relief may be made. A report should also be made of all cars in excess of those actually required, unless the conductor has orders to hold them.

Passengers Not Allowed in Baggage Cars or on Platforms. Passengers must not be allowed to ride in baggage or express cars or upon car platforms, unless necessary on account of overcrowding, or upon the engine without a permit.

Obstructing Aisles. Passengers must not be allowed to carry bulky articles or packages into the cars

which would obstruct the aisles, seats or the spaces between seats to the inconvenience of other passengers. Articles or packages of this description must be sent to the baggage car and checked, and if not entitled to be carried as baggage they should be forwarded by express or otherwise disposed of by the owner.

Ventilation and Temperature. All passenger cars should be kept properly ventilated and when artificial heat is in use a proper and even temperature should be maintained at all times.

Peddling and Soliciting. A conductor must see that no unauthorized peddling or soliciting is done on his train, that no beggars, gamblers or confidence men are allowed to ply their operations, and that news agents and other licensed solicitors do not annoy passengers by placing articles in their laps or exercise undue efforts to sell goods and secure patronage, or otherwise annoy passengers.

Disorderly or Intoxicated Passengers. Drunken persons who are disorderly and troublesome should not be allowed to board the train when it is possible to discriminate; intoxicated persons and others on the train must not be allowed to use profane or obscene language, or to damage the company's property.

The rules and regulations of the company relating to drunken or disorderly persons must be enforced in a courteous manner and without attracting unnecessary attention. If the request of the conductor is disregarded an ejectment from the train is necessary. This action should be taken at the first open station at which the train stops.

Dining and Sleeping Cars. When passing through dining cars where meals are being served, or through occupied private cars, the conductor and other train employes must remove their caps. All possible quietness must be maintained in and about sleeping cars at night. When entering and passing through them, employes must move quietly and cover their lanterns. All switching and coupling must be done carefully to avoid shocks and violent movements. Conversation by trainmen, inspectors and other employes in and about occupied sleepers must be limited to that which is necessary for the management of the train and should be carried on in as low a tone as practicable.

Connections. A conductor should be posted in regard to connections and time of connecting trains. When examining the tickets of passengers destined to points on connecting lines, he must notify such passengers where they are to change cars and where the trains of other lines will be found.

Announcements of Meals. Announcements of meals necessary for the information and guidance of passengers must be properly made. At terminals and meal stations announcements must be made distinctly, in the waiting, dining and lunch rooms immediately before starting; at other stations the necessary announcements must be made upon the station platform.

Transportation. As far as practicable a conductor must see that passengers have proper transportation before entering the train, unless otherwise prescribed by rule.

Each passenger should be required to present a proper ticket or pass, or pay the prescribed fare, and in case of failure to do so, should be ejected from the

train at the next open station. If, in the opinion of the conductor, the circumstances of any case warrant a waiver of this rule, such action may be taken and a report of the case made to the proper official.

Ejectment of Passengers. If it becomes necessary to eject a passenger, this duty should be performed with coolness and moderation. When the train stops, the passenger must be requested to get off. Only in case of a refusal to comply with this request must force be employed, and then the ejectment must be accomplished without unnecessary violence. After the train has been stopped for the especial purpose of making an ejectment, or after an ejectment has been made at a regular stop, a tender of fare or a promise to comply with the rules should be accepted only at the discretion of the conductor. Whenever it is found necessary to eject a passenger for violation of the rules, the ticket of such passenger properly endorsed for the remainder of the ride, or a proportionate amount of the cash fare paid, as the case may be, must be returned, or at least tendered.

In cases of ejectment or any other difficulty with passengers, the conductor must, if possible, obtain the names and addresses of all witnesses and such names and addresses must be included in the report of the occurrence made to the proper official. The number and description of any ticket or pass presented should also be given.

When a passenger, who is under the influence of liquor, or is otherwise disqualified to take care of himself, is discharged from a train, he should be placed under the care of the station agent or some other station employe in order that he may be protected from

personal injury while on the company's premises. The police powers given conductors by law should be exercised when necessary to quell disturbances or to protect persons and property.

U. S. Mail. In the event of any irregularity of delivery of U. S. mail to the train, a record must be kept and a report of the occurrence made.

Setting Out or Adding Coaches. When adding cars to a train at intermediate points, a conductor must see that the air brake, steam heat and air signal appliances are recoupled and in working order.

When passenger cars are left at way stations or on sidings, he must see that the doors and windows are closed and locked, and that the hand brakes are set.

Reporting Defective Equipment. A report of any defective cars in the train, any imperfect action of the air brakes, or other appliances should be made to the car inspector or other repair man upon arrival at a terminal. When necessary, a report of such defects should be made to car repairers at intermediate points, and repairs made if they are of sufficient importance to warrant delay to the train. A report of any equipment in the train which is inferior or unfit for service must be made to the superintendent or other superior official.

Good Judgment and Courtesy. A passenger conductor should never lose sight of the fact that his duties are of a most delicate and responsible character, and demand unusual judgment, tact and courtesy, and that the safety of his train and passengers and the reputation of the road are dependent upon his discretion and care and that of his trainmen.

DEFINITIONS OF SIGNALS.

A thorough knowledge of the signals required in train operation is essential to every employe. They are classified as Visible, Audible, Train, Hand, Lamp and Fixed.

VISIBLE SIGNALS.

Visible signals are those which can be seen, such as lanterns, flags, fusees, hand and fixed.

Signal Appliances. Employes whose duties require them to give signals must provide themselves with the proper appliances, which must be kept in good condition and ready for immediate use. Employes giving signals must place themselves in a position where they may be plainly seen by enginemen or others to whom the signals are given. All signals must be given clearly in such a manner that they may not be misunderstood. The utmost care must be exercised to avoid taking the wrong signal when two or more trains are passing each other at stations or when moving through yards. Unless all employes on the train are absolutely certain that the signal given is intended for them, they must not move their train until communication is made by word of mouth.

Day and Night Signals. The standard rules are that night signals must be displayed from sunset until sunrise, and when weather or other conditions obscure day signals or make it difficult for employes to distinguish them clearly, night signals must be used in addition to the regular day signals.

COLOR INDICATIONS.

Red Signals. A red signal has but one meaning—DANGER—STOP!—and is the most important signal used in train operation. A failure to obey this signal may lead to the destruction of property and the loss of life.

Green Signals. A green signal indicates SAFE—PROCEED! It has also other uses, prescribed by the rules of different railroads. Some roads use the green signal as a caution signal. When this signal is displayed, the train may proceed under full control, but must be prepared to stop within the vision of the engineman upon display of a danger signal.

White Signals. A white signal indicates SAFETY—PROCEED! A white lantern is used at night by train employes and others for giving night signals. White signals are also used for other purposes prescribed by the rules of the company.

Green and Red Signals. On some roads a green and red signal displayed in combination indicates PROCEED WITH CAUTION. A red and a green light would be used for displaying this signal at night, and a red and a green flag by day. When this signal is displayed, a train may proceed under control, prepared to stop upon the display of a danger signal.

Combined Green and White Signals. A combined green and white signal is a standard signal and is used only for the purpose of stopping a train at flag stations indicated on its schedule, for the purpose of receiving passengers or freight. A flag station is one at which the train makes no stop except upon the display of the proper signal. Any necessary stop is made

at stations of this class only upon the display of a flag signal.

Blue Signals. A blue flag by day and a blue light by night displayed at one or both ends of an engine, car or train, indicates that workmen are under or about it. Repairmen and others are required by rule to protect themselves, displaying these signals while making repairs to engines or car equipment placed on repair tracks. While such signals are displayed, cars or engines so protected must not be coupled to or moved. The workmen must be notified before other cars or engines are placed on the same track in such a manner as to prevent a clear view of these signals. Repairmen are the only employes authorized to display blue signals and the same workmen are the only ones permitted to remove them.

Yellow Signals. Yellow Signals are used on some roads as caution signals only.

Caution Signals. A caution signal placed alongside of the main track indicates RUN SLOW—POOR TRACK, and a train must proceed with caution. The color of this signal depends upon the color adopted by the employing company to be used as a caution signal.

FUSEES.

A fusee is a circular tube from 12 to 15 inches in length filled with red or green burning powder and provided with a sharp metal point at one end and a sulphur filling on the opposite end. It is lighted by removing the friction cap and rubbing it firmly against the sulphur end, after which the fusee is stuck into a tie or thrown to the ground from a moving train.

Red Fusees. A lighted fusee burning red, placed on or near the track, is a signal to stop and must not be passed until burned out, after which the train may proceed under control, prepared to stop upon the display of a danger signal.

Green Fusees. A lighted fusee burning green is used as a caution signal. When this signal is displayed, a train is not required to stop, but may proceed under control, prepared to stop upon the display of a danger signal.

HAND, FLAG AND LAMP SIGNALS.

Hand signals, as their name indicates, are given with the hands, and are used as a means of transmitting signals to members of the crew by day.

Lamps are used at night for transmitting the same signals and are similar in form to the hand signals given by day, except that a white lantern is used as the indicating medium instead of the hand. A careful study of the standard hand and lamp signals, which are illustrated in the diagram section of standard signals, will show the correct manner in which the signals should be given.

Manner of Using.	*Indication.*
(a) Swung across the track.	Stop.
(b) Raised and lowered vertically.	Proceed.
(c) Swung vertically in a circle at half arm's length across the track when the train is standing.	Back.
(d) Swung vertically in a circle at arm's length across the track, when the train is running.	Train has parted.
(c) Swung horizontally above the head, when the train is standing.	Apply air-brakes.
(f) Held at arm's length above the head, when the train is standing.	Release air-brakes.

Any object waved violently by anyone on or near the track is a signal to stop.

AUDIBLE SIGNALS.

Audible signals are those given by sound, such as those given by whistle blasts, the explosion of torpedoes or the air whistle, the latter signal being used on passenger trains only.

Steam Whistle Signals. A code of long (———) and short (o) blasts of the steam whistle is used on all American railroads for transmitting signals to others.

Sound.	*Indication.*
(a) o	Stop. Apply brakes.
(b) —— ——	Release brakes.
(c) —— o o o	Flagman go back and protect rear of train.
(d) —— —— —— ——	Flagman return from west or south.
(e) —— —— —— —— ——	Flagman return from east or north.
(f) —— —— ——	When running, train parted; to be repeated until answered by the signal prescribed by Rule.
(g) o o	Answer to any signal not otherwise provided for.
(h) o o o	When train is standing, back. When train is running, answer to communicating signal (d).
(j) o o o o	Call for signals.
(k) —— o o	To call the attention of yard engines, extra trains or trains of the same or inferior class or inferior right to signals displayed for a following section.
(l) —— —— o o	Approaching public crossings at grade.
(m) ————————	Approaching stations, junctions and railroad crossings at grade.

AIR SIGNAL COMMUNICATING SIGNALS.

Sound.	*Indication.*
(a) Two.	When train is standing, start.
(b) Two.	When train is running, stop at once.
(c) Three.	When train is standing, back the train.
(d) Three.	When train is running, stop at next station.
(e) Four.	When train is standing, apply or release air-brakes.
(f) Four.	When train is running, reduce speed.
(g) Five.	When train is standing, call in flagman.
(h) Five.	When train is running, increase speed.

TRAIN SIGNALS.

Train signals are any sign or indication that may be seen or heard, on or about a train to indicate its class and for the purpose of communicating with others.

Markers. Markers are required on the rear of every train. They consist of two green flags by day and two combination lamps by night, the lamps having four colored lenses, three of which show green and the other red.

At night when running, the markers are displayed with the red lenses to the rear and green lenses to the sides and front. The red lens, visible to the rear, is a danger signal for following trains. The green lens, to the sides, indicates to signalmen, operators and all others concerned that the entire train has passed. When a train is standing into clear on a siding to meet or to be passed by another train, the markers are turned with green lens to rear and sides and the red lens to the inside, in order that the engineman of a following train will not mistake the red light for a signal to stop, and it is also an indication that the train is into clear of the main track.

Markers should never be removed at the terminal until the train is into clear of the main line and the switch closed.

Headlights. The headlight must be displayed on the front of every engine by night, but should be concealed when a train turns out to meet another and has stopped clear of the main track, or is standing to meet trains at the end of double tracks, or at junction points.

White Light on Leading Car. A white light must be displayed by night on the forward end of the leading car, when cars are being pushed by an engine. This rule does not apply except when trains are being shifted or made up in yards.

Caboose Indicators. Letters and figures are placed in the indicator of the caboose cupola, to designate their numbers. For regular trains, the train number only will appear in the indicator. If the train is run in two or more sections, the first section will show "1st section," the second "2nd section," etc. The letters "L. S." will be shown on the last section, in ad-

dition to the regular train number. If the train is an extra, the word "EXTRA" will appear in the indicator.

Communicating Signal Appliances. Each car on a passenger train must be connected to the engine by an air signal appliance in order that trainmen may transmit signals to the engineman by means of the whistle cord which passes throughout the train. (See train air signal system, Part II.)

FIXED SIGNALS.

Fixed signals are those of fixed location, the condition of which affects the movement of trains, and are classified as train order, interlocking, home, distant, block, switch, pot and dwarf.

Interlocking Appliances. Interlocking appliances consist of switch, lock and signal appliances, which are so connected that their movements must follow one another in a predetermined order.

Interlocking Signals. An interlocking signal is a fixed signal and is operated in connection with an interlocking plant, of which it forms a part.

Interlocking Plant. An interlocking plant consists of an assemblage of switch, lock and signal appliances, connected and interlocked in such a manner that each switch, lock and signal can be operated only as a complete device.

Home Signals. A home signal is a fixed signal located at points at which trains are required to stop when the route is not clear, and are used at block stations and interlocking plants.

Distant Signals. A distant signal is used as a caution signal in connection with a home signal, to

regulate the speed of approaching trains to the home signal. If a white signal is displayed at the distant signal, a train will proceed at its customary speed. If a caution signal is displayed, the train will proceed under control to the home signal.

Dwarf Signals. A dwarf signal is a low fixed signal of the semaphore type, and is usually used in yards at switches leading to sidings.

Pot Signals. A pot signal is a low revolving signal, used as a substitute for a dwarf signal, and is most commonly used in yards.

Signal Mast. A signal mast is the upright post which supports the signal arm and disk of a semaphore. It is used only for the purpose of displaying signals in such a position that they can be seen and distinguished by those for whom they are intended.

Signal Arm. A signal arm is a moveable board, the position of which determines the signal indication. When the signal arm is displayed in a horizontal position on a distant semaphore it indicates "caution," and the train may proceed under control, expecting to find the home signal displayed at "stop."

When the arm of a home signal is in a horizontal position, it indicates "stop," and the train will not proceed beyond this signal until a clear or caution signal is displayed. On double track roads where the semaphore signal is used for electric blocking, the train will be brought to a full stop when the semaphore arm is displayed in a horizontal position, and may then proceed with caution to the next signal. If the signal is operated in connection with an interlocking plant at a station, the train will not proceed until clear signal is given.

When the signal is displayed in a diagonal position it indicates "clear," and the train may proceed at its usual speed.

Signal Disk. A signal disk is that portion of a semaphore from which a signal indication is given by night. It is made in the form of a glass lens and is colored red and white, or red and green, the color of the signal being determined by the position of the disk. They are displayed on the opposite side of the mast from that of the semaphore arm, and to the left of the signal mast, the indications being shown by means of a light placed behind the disk. Semaphore arms are displayed to the right of the mast as seen from an approaching train.

Shape and Color of Distant and Home Signals. The arm of the distant signal has a forked end, and is painted with the colors used by the employing company for caution signals, which are green or yellow. The arm of a home signal has a square end, and is painted red with a white band near the end.

THE TELEGRAPH BLOCK SIGNAL SYSTEM.

"Block Systems" and "Block Signals" are the terms used when describing any system of blocking trains. The term "Block System" is used to designate any means of maintaining a predetermined interval or space between two trains running in the same direction on the same track. The practice of using a time interval is still in common use on many roads where trains may follow one another at intervals provided for by the rules, this method of blocking is called "spacing."

Block systems are most commonly used with two or more tracks, but are also used to a large extent on single tracks, the benefits derived are as applicable to single as to double tracks under the same conditions. Some of the states have statutes compelling railroads to adopt suitable block signals on all divisions having a given earning capacity.

Block Signal Rules and the manner in which they are enforced are unlike train rules and train orders in the way of being standardized, each individual road having their own rules for the guidance of their employes. In fact, it would be a difficult matter to promulgate a standard set of rules at the present time that would cover all of the different appliances used in the operation of block signals, some of the systems being in an experimental stage, while modifications and improvements are constantly being made in the older systems of electric and mechanical blocking,

nearly all of the older devices having been superseded by the later improved systems. The mileage of block signals throughout the country is rapidly increasing, and if an attempt were made to describe all of the signal rules now in effect on the different roads, it would require a volume in itself.

One of the most important factors in using block systems or space intervals on double or single track is the qualifications and reliability of trainmen, who are expected to protect the rear of their train, and especially during winter months in sections of the country where severe cold weather is encountered, under which circumstances a flagman out three-fourths of a mile from his train can only be considered as an unreliable protection against accident. However, these conditions are beyond human control.

The following Block Signal Rules are not to be considered as standard rules, but they are those which are in most common use.

BLOCK SIGNAL RULES.

Block signals are in the form of fixed signals and are used to control the movement of trains in a block.

Block signals do not affect the movement of trains under the time table or train rules, neither do they relieve a conductor from the necessity of protecting his train by means of a flagman as occasion requires.

When a block signal is set at "clear," it will show an arm in a diagonal position by day and a green light by night; when at "danger" an arm in a horizontal position by day and a red light at night.

When the signal is at "clear" it gives a train a

clear track to the outer approaching switch at the next signal block station. By an outer approaching switch is meant the first switch reached when approaching a siding where trains can meet or pass.

Block signals do not control the movement of trains standing upon sidings. Authority from the signalman or operator handling the signals is required before a train standing upon a siding may proceed.

The authority may be in the form of a caution card or release stamped "block is clear," a train order stamped "block is clear," or train orders and a caution card.

A train moving under a caution card may expect to find the main track occupied within that block.

When two or more trains coupled together are in a block, they may be uncoupled only at a block station, and the signalman must be notified.

Before a train crosses from one main track to another, a cross-over permit must be secured. This form of permit is issued only upon authority of the train dispatcher.

A train after clearing a block is not permitted to re-enter it, or back within 300 feet of the block without authority from the signalman.

When a train is passing a block signal the members of the train crew should watch the signal until the entire train has passed.

If a train arrives at a block signal station where a signalman is regularly stationed, and finds the signal set at danger and the signalman is absent, the train must wait at least ten minutes and then proceed to the next block station, where the conductor should report the facts to the train dispatcher. This rule ap-

plies to an intermediate station where there are no sidings.

When a train which has broken in two and is recoupled, the conductor should immediately notify the signalman at the nearest block station.

Hand signals will not be accepted as against block signals.

When the track is obstructed between block stations, the conductor must notify the signalman at the nearest block station.

After a train enters a siding at a block station, the conductor must personally notify the signalman when the train is clear of the main track and the switches locked.

An intermediate siding is a siding between two open block switches.

A train of an inferior class accepting a clear signal at a block station, expecting to make the next block station on its time card rights against a superior train, must take an intermediate siding if there is one between blocks, if through delay it is unable to reach the next block station. If unable to reach the siding, the train should be protected by a flagman. The train of superior class may proceed by authority of a caution card.

When two trains are scheduled to meet at an intermediate siding, a release is required showing that train order signals are displayed for those two trains to meet at such siding. If the inferior train fails to make the meeting point, the superior train may proceed on its time table rights, but with caution.

If two trains are to meet by special order at an intermediate siding, a release stating that signals are displayed for such trains to meet at the intermediate sid-

ing is required, in addition to the special order before the trains may enter the block.

Ten Minute Block. In districts not controlled by a telegraph block system, trains moving in the same direction must keep ten minutes apart.

DEFINITIONS OF BLOCK SIGNALS.

A block is a length of main track within defined limits and controlled by block signals.

Positive blocks are those in which but one train is allowed at a time.

A permissive block is one in which two or more trains are allowed at the same time through the use of caution cards or train orders.

A block station is a place from which block signals are operated.

A block signal is a fixed signal controlling the movement of trains within a block.

A home block signal is a fixed signal at the entrance to a block to control the movement of trains entering the block.

A distant signal is a fixed signal used in connection with a home signal to regulate the approach of trains to the home signal. When a distant signal is set at caution it indicates that the home signal may be at "stop;" when the distant signal is at clear, it indicates that the home signal is also clear.

An advance block signal is a fixed signal used in connection with a home block signal to subdivide the block in advance.

A block system consists of a series of consecutive blocks.

A telegraph block system is one in which the sig-

nals are operated manually upon information furnished by telegraph.

A controlled manual block system is one in which the signals are operated manually and are so constructed that the co-operation of the signalman at both ends of a block is necessary to display a clear signal.

An automatic block system is one in which the signals are operated by electric, pneumatic or other agency, which is actuated by the movement of trains, or by certain conditions affecting the use of the block.

Signals Used in Automatic Blocking. Either the semaphore or the enclosed disk are used in connection with the automatic block system.

On single track roads, semaphore or disk signals are placed to the right of the track; on double track roads they are usually placed to the right of the track to which they govern, although this rule varies on different roads. For single or double tracks the signals may be attached to one mast. On roads having three tracks, or over, the signals are usually placed immediately over the tracks to which they govern, being supported by a frame work or bracket extending across the tracks.

When semaphore or disk signals are supported on brackets, the signal to the right of the bracket governs the track on the extreme right; the next signal to the left of the first governs the track to the left of the first track, and so on.

When an indicator disk is visible at a main track switch, it indicates that the head of an approaching train has reached a point within 1,000 feet in advance of the block signal protecting the switch.

The indications for the main running track are given by means of a high home signal.

Even numbered signals govern the movement of trains to the south or east, while odd numbered signals govern to the west or north.

When a semaphore signal is used the arm is displayed to the right of the mast as seen from an approaching train. This arm has two positions, diagonal and horizontal. At night a green or white light will be displayed to indicate clear, and a red light to indicate danger.

On roads where signal disks are used, the indications are given by the positions of the red or clear disk by day, and by lights of the same color by night.

A home semaphore when at "stop" will display the arm in a horizontal position by day, and a red light at night. When at clear it will show the arm in a diagonal position by day and a green light by night.

When two signals are displayed from the same mast, the upper one is the home block signal for the block in advance—the lower signal is the distant signal for the second block in advance.

To indicate "caution" on a distant semaphore, the arm is displayed in a horizontal position by day and a green and red light are displayed at night.

To indicate "clear" on a distant semaphore, the arm is displayed in a diagonal position by day, and a green light is shown by night.

A " stop" signal on a home disk is indicated by the display of a red disk by day and a red light by night.

A "clear" signal on a home disk signal is indicated by the withdrawal of the red disk from view by day and the display of a green light by night.

To indicate "caution" on a distant disk signal, a

green disk with a white cross on its face is displayed by day, and a red and green light by night. A caution signal of this kind indicates "proceed with caution to the home signal."

To indicate "clear on a distant disk signal, the disk is withdrawn from view by day, and a green light is displayed by night.

When a train is stopped by an automatic block signal, it may proceed after the signal changes to "clear" or after waiting one minute and the signal does not clear, the train should proceed with caution to the next clear signal.

When a signal is out of service it is covered with a white shield. When found in this condition without notice, the train should proceed with caution to the next clear signal.

A conductor finding a signal out of order should immediately report the defective signal to the superintendent.

When a home signal indicates stop it signifies that the block is occupied, that a switch is wrong in the block, that a car is foul of the main track or that the signal apparatus is out of order.

A conductor of a train must not allow his train to pass from a siding to the main track, while a red disk is shown in the indicator box, but must wait until the red disk disappears from view before turning the switch.

A switch may, however, be opened to permit a train to move from the main track to a siding, when the red disk is visible in the indicator box at the switch.

DIAGRAMS

HAND, FLAG AND LAMP SIGNALS.

NOTE.

The hand, or a flag, moved the same as the lamp, as illustrated in the following diagrams, gives the same indication.

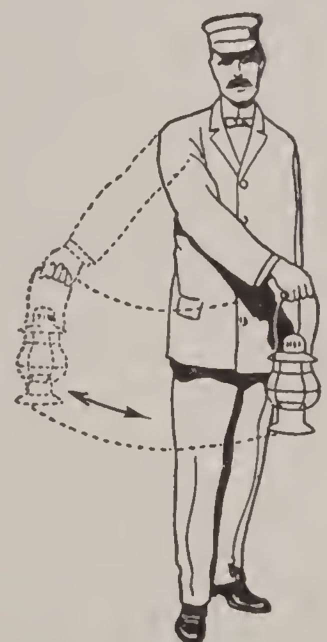


Fig. 1

Stop—Swung across the track.

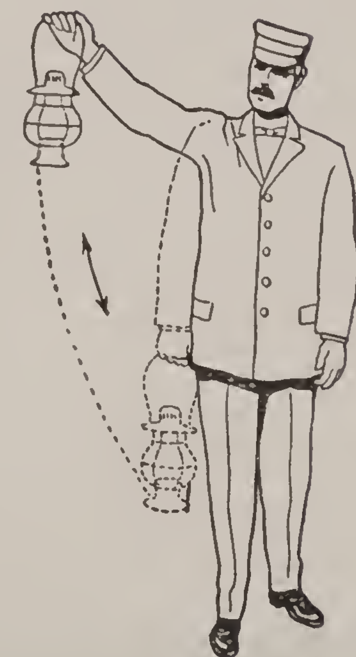


Fig. 2.

Proceed—Raised and lowered vertically.

Fig. 3.

Back—Swung vertically in a circle at half arm's length across the track.

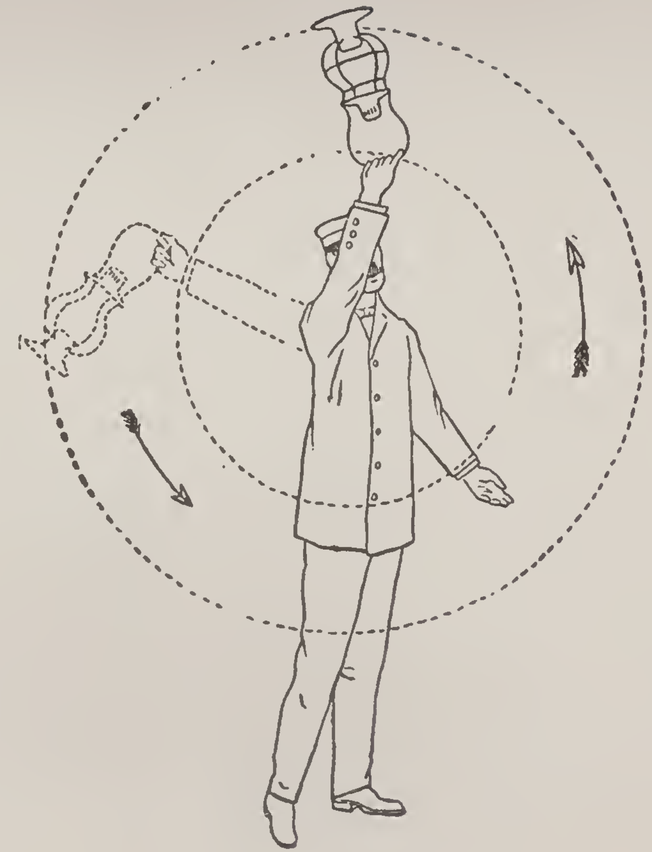


Fig. 4.

Train has parted—Swung vertically in a circle at arm's length across the track.

Fig. 5.

Apply Air Brakes—Swung horizontally at arm's length above the head.

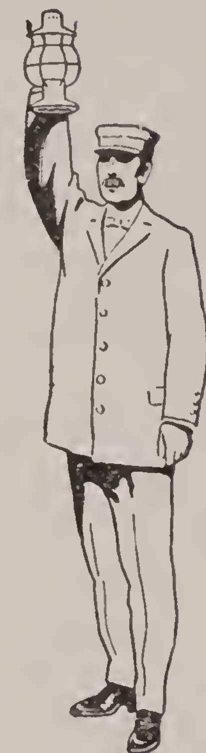


Fig. 6.

Release Air Brakes—Held at arm's length above the head.

DIAGRAMS

OF

TRAIN SIGNALS.

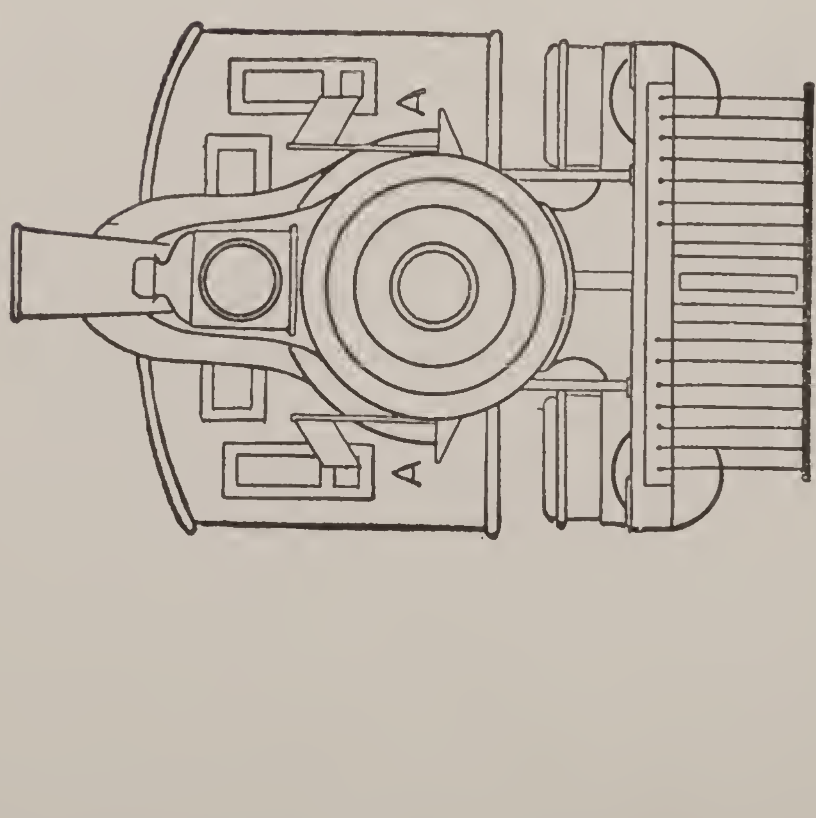


Fig. 7.

Engine running forward by day as an extra train —White flags at A A.

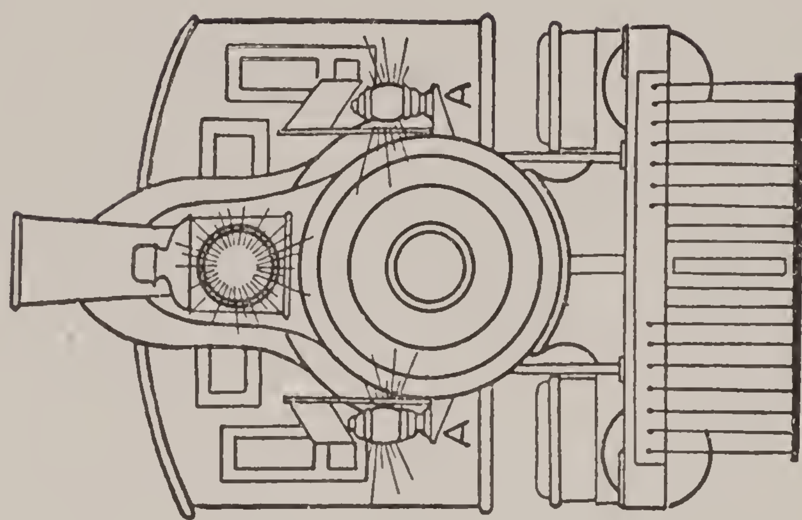


Fig. 8.

Engine running forward by night as an extra train—White lights and White flags at A A.

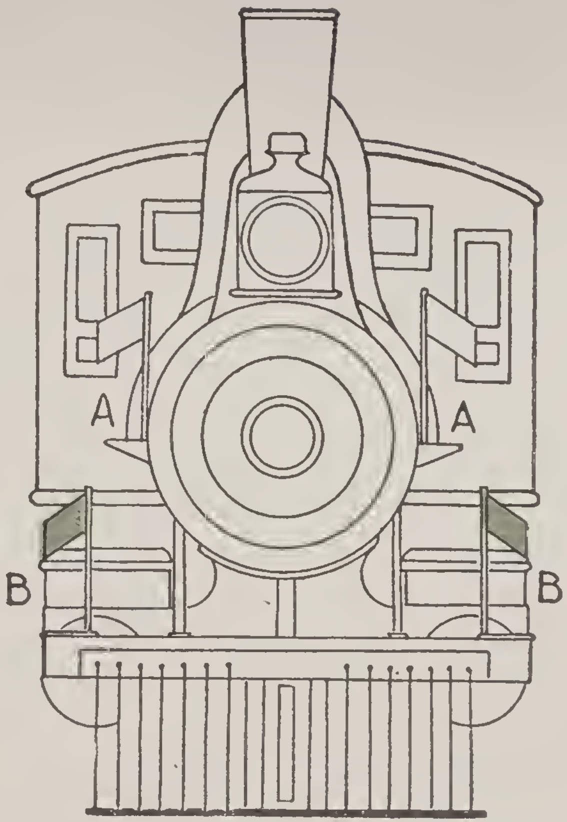


Fig. 9.

Engine running backward by day as an extra train, without cars or at the rear of train pushing cars—White flags at A A. Green flags at B B as markers.

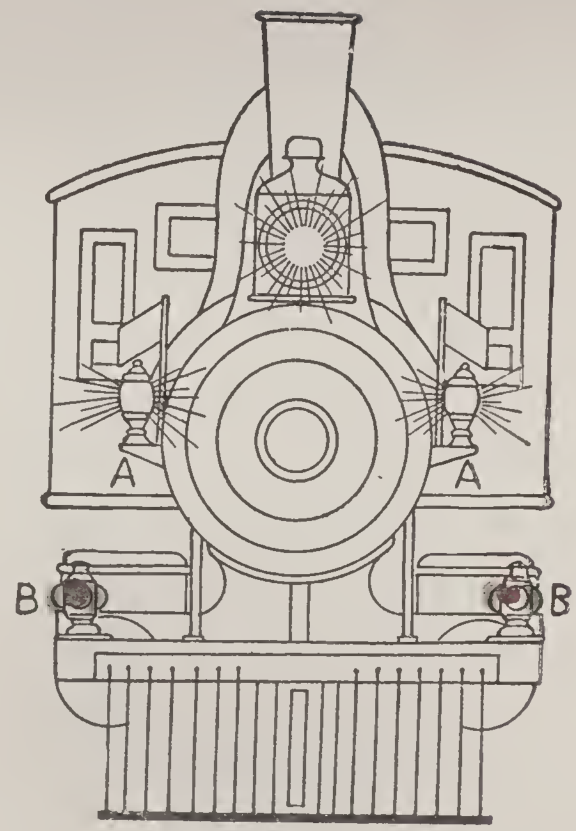


Fig. 10.

Engine running backward by night as an extra train, without cars or at the rear of a train pushing cars—White lights and White flags at A A. Lights at B B as markers, showing Green at side and in direction engine is moving, and Red in opposite direction.

Fig. 11.

Engine running forward by day displaying signals for a following section—Green flags at A A.

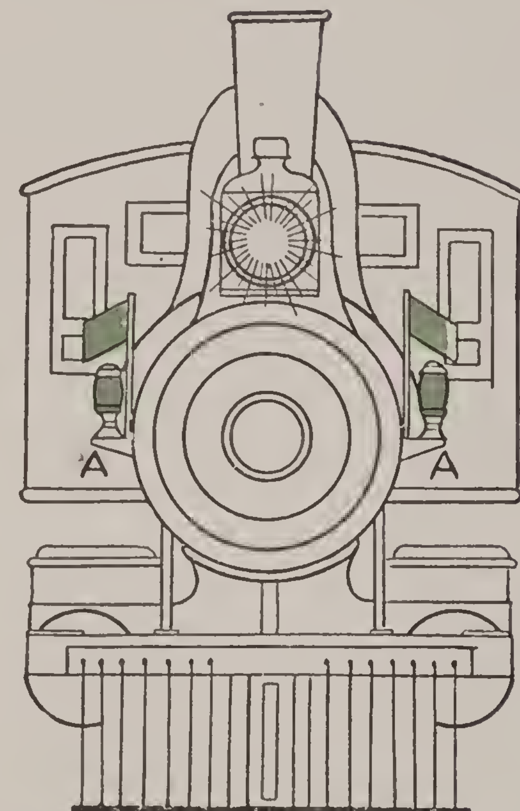


Fig. 12.

Engine running forward at night displaying signals for a following section—Green lights and Green flags at A A.

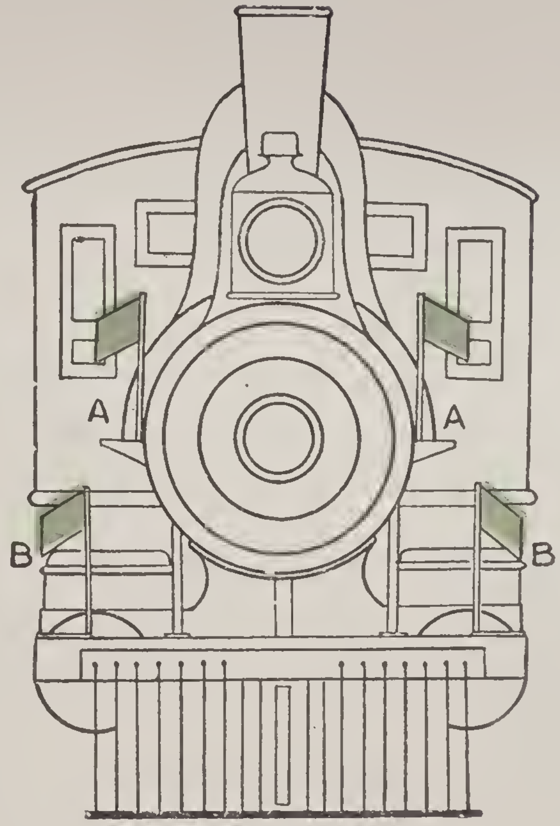


Fig. 13.

Engine running backward by day, without cars or at the rear of a train pushing cars, and displaying signals for a following section—Green flags at A A. Green flags at B B, as markers.

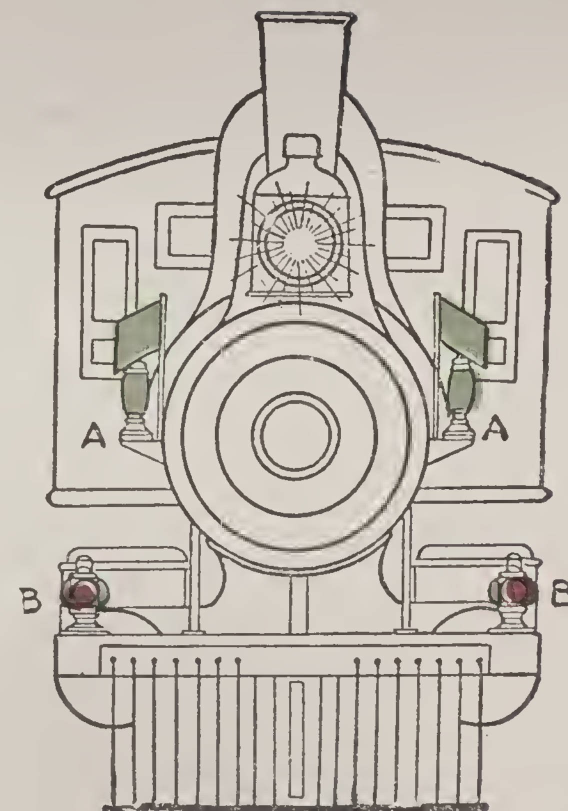


Fig 14.

Engine running backward by night, without cars or at the rear of a train pushing cars, and displaying signals for a following section—Green lights and Green flags at A A. Lights at B B as markers, showing Green at side and in direction engine is moving, and Red in opposite direction.

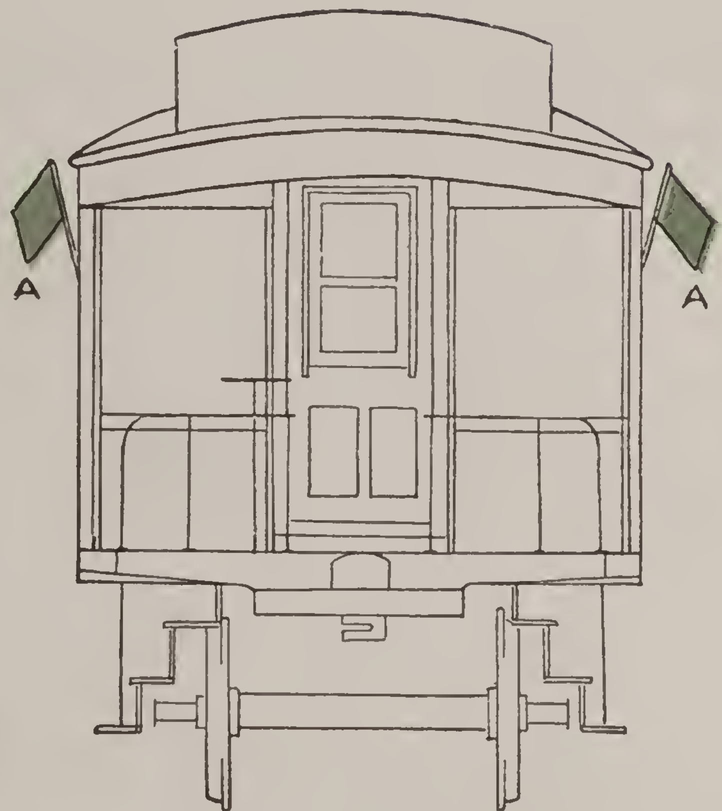


Fig. 15.

Rear of train by day—Green flags at A A, as markers.

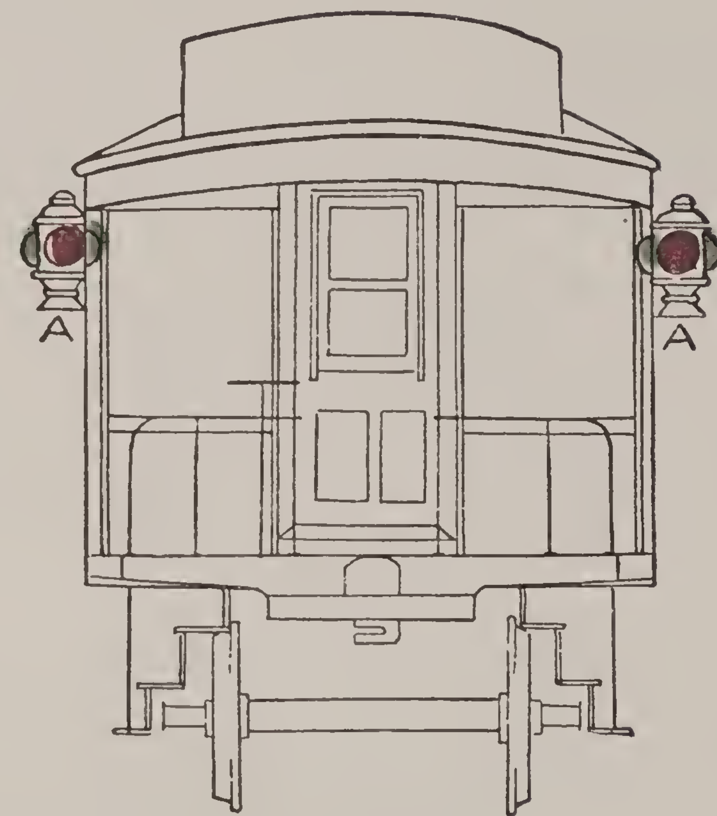


Fig. 16.

Rear of train by night running with the current of traffic—Lights at A A, as markers, showing Green toward engine and side and Red to rear.

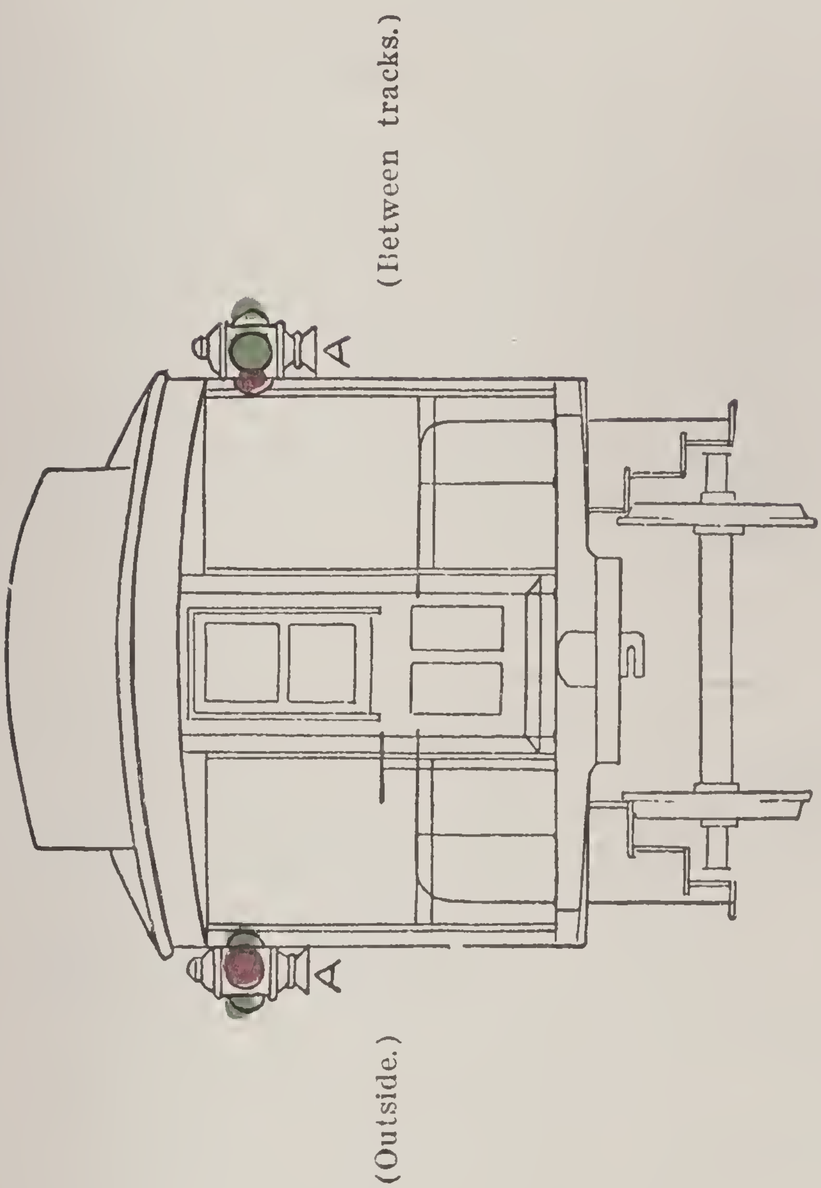


Fig. 16 A.

Rear of train by night running against the current of traffic. (This illustration is for a road which uses the right-hand track.)—Lights at A A, as per Rule D-19.

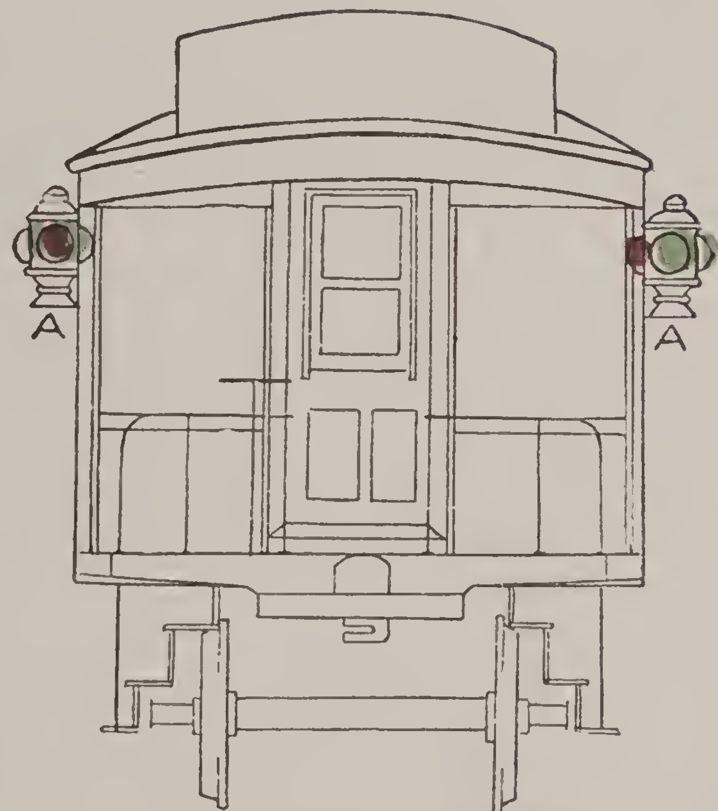


Fig. 17.

Rear of train by night when on siding to be passed by another train—Lights at A A, as markers, showing Green toward engine, side and to rear.

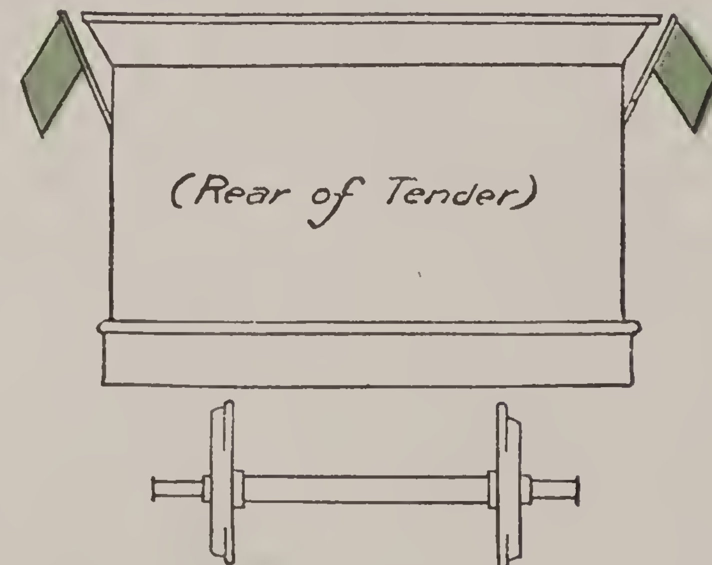


Fig. 18.

Engine running forward by day, without cars or at the rear of a train pushing cars—Green flags as markers.

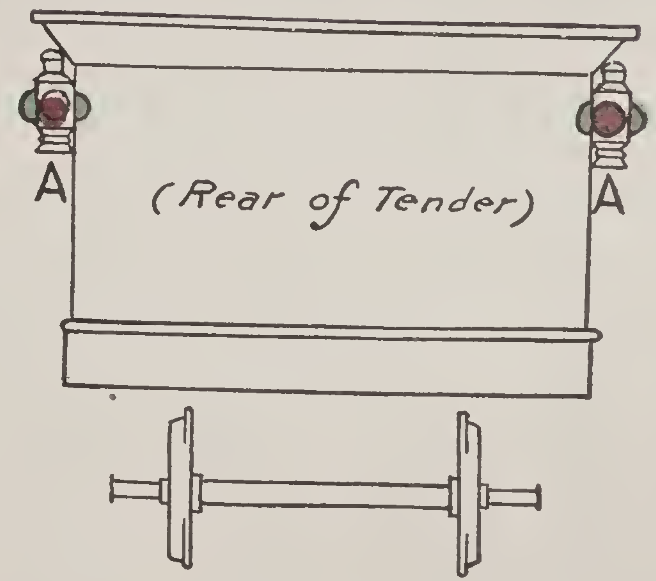


Fig. 19.

Engine running forward by night, without cars, or at the end of a train pushing cars—Lights at A A, as markers, showing Green to the front and side, and Red to rear.

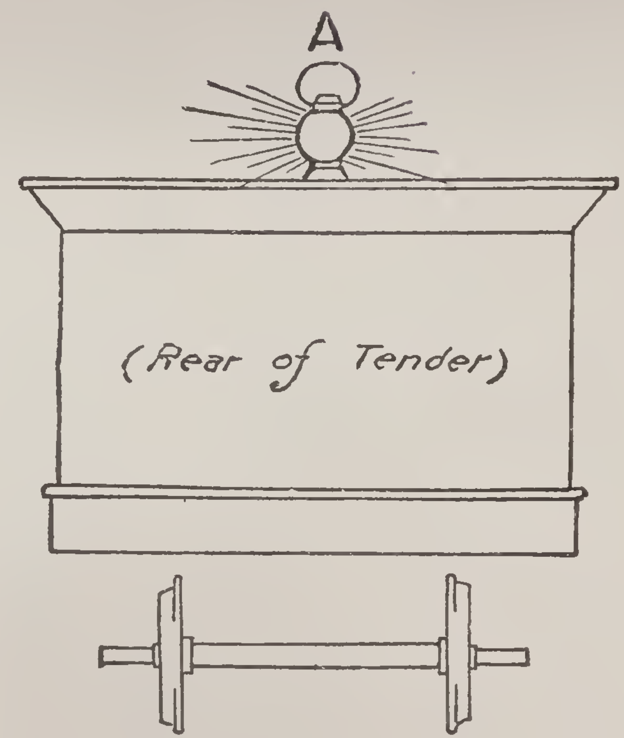


Fig. 20.

Road engine running backward by night, without cars, or at the front of a train pulling cars—White light at A.

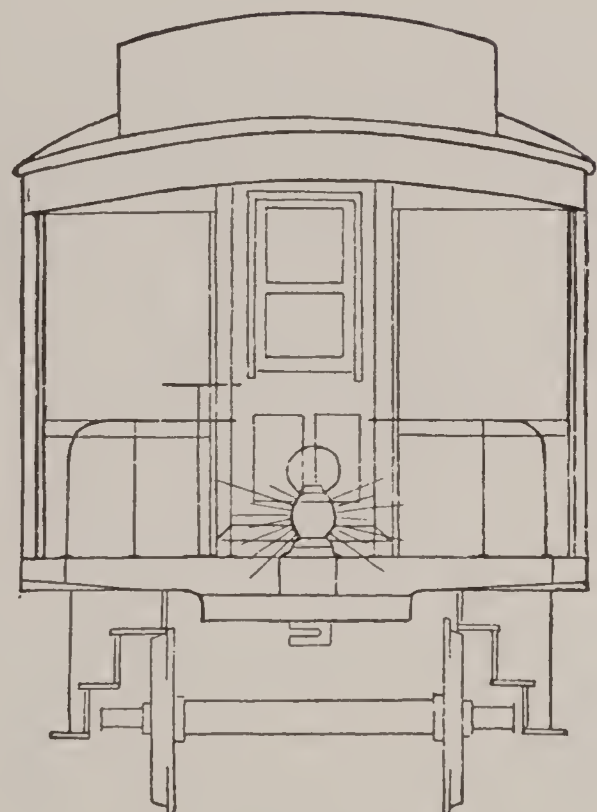


Fig. 21.

Passenger cars being pushed by an engine by night—White light on front of leading car.

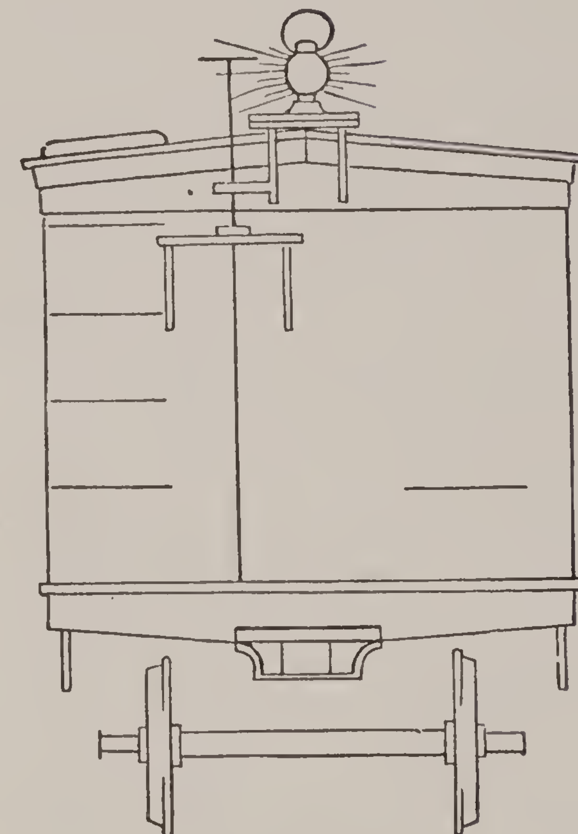


Fig. 22.

Freight cars being pushed by an engine by night—White light on front of leading car.

DIAGRAMS

OF

FIXED SIGNALS.

NOTE.

The colors used for caution signals vary, on different roads.

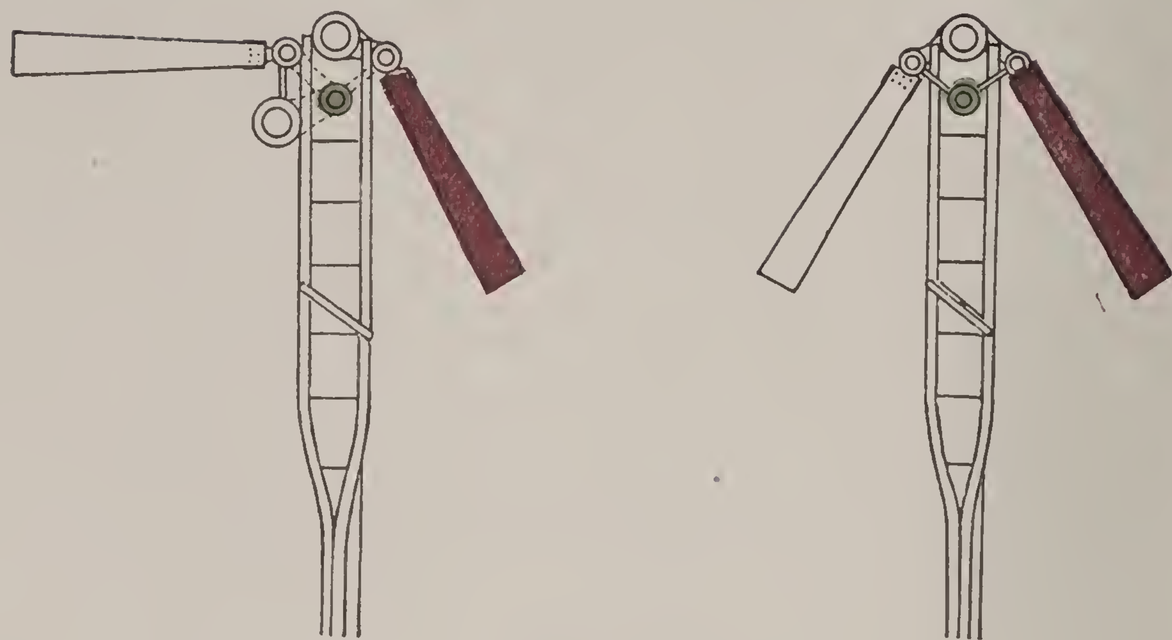


Fig. 23.

Train Order Signal or Telegraphic Block Signal.

Color—Green light at night. Indication—Proceed.

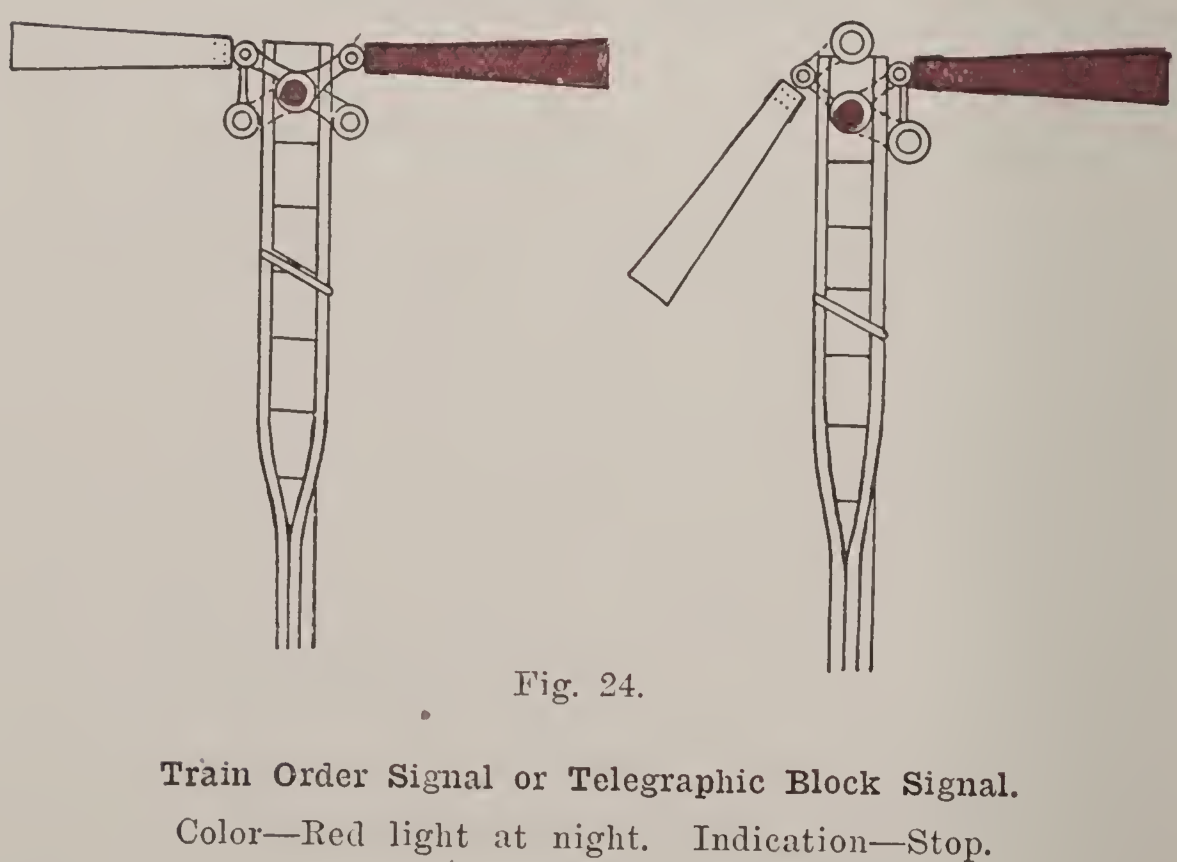


Fig. 24.

Train Order Signal or Telegraphic Block Signal.

Color—Red light at night. Indication—Stop.

Day Night

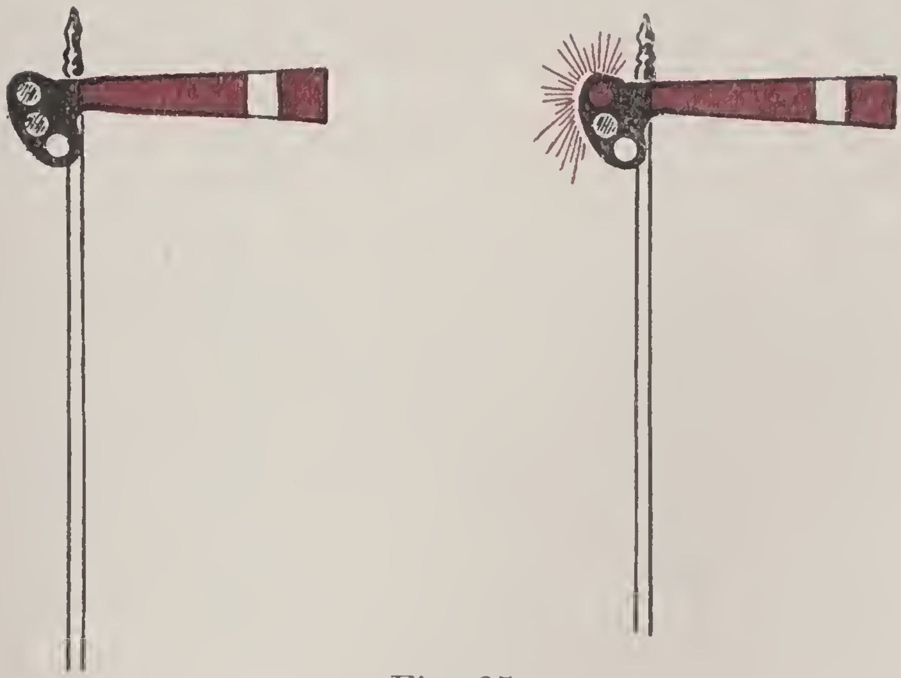


Fig. 25.

Home Signal.

Color—Red light at night. Indication—Stop.

Day Night

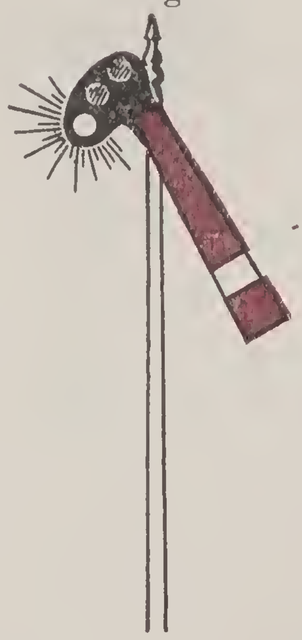


Fig. 26.

Home Signal.

Color—White light at night. Indication—Clear signal.

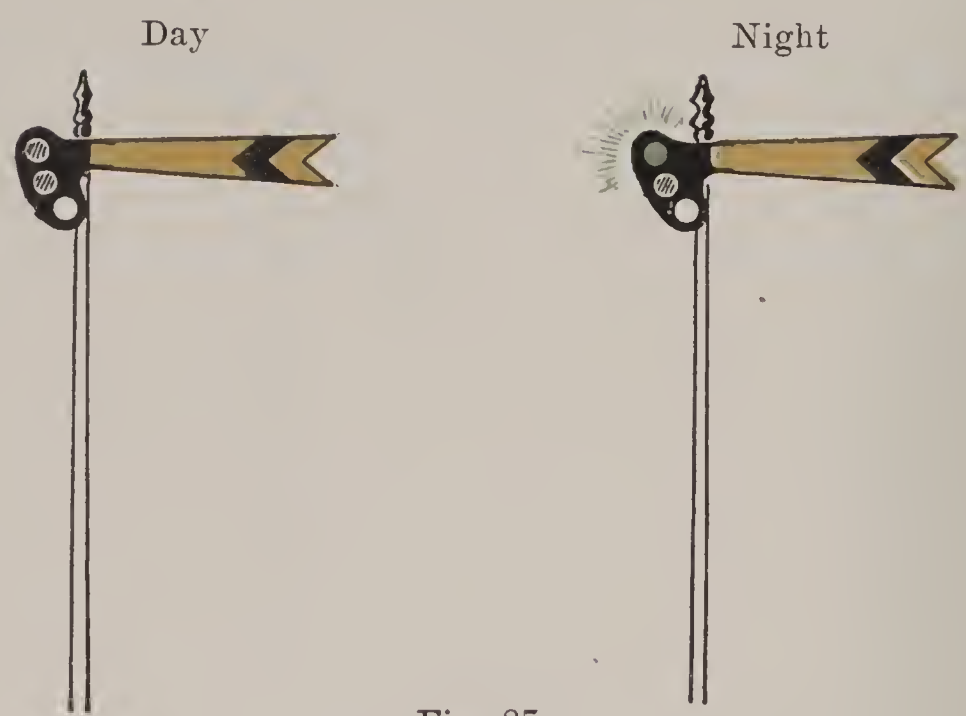


Fig. 27.

Distant Signal.

Color—Green light at night. Indication—Caution.

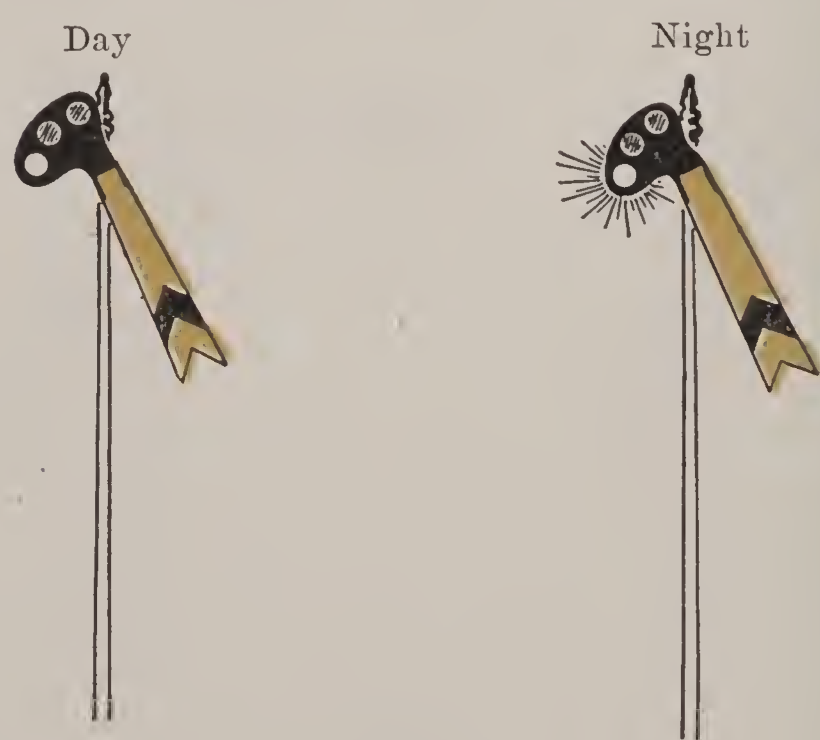


Fig. 28.

Distant Signal.

Color—White light at night. Indication—Clear signal.

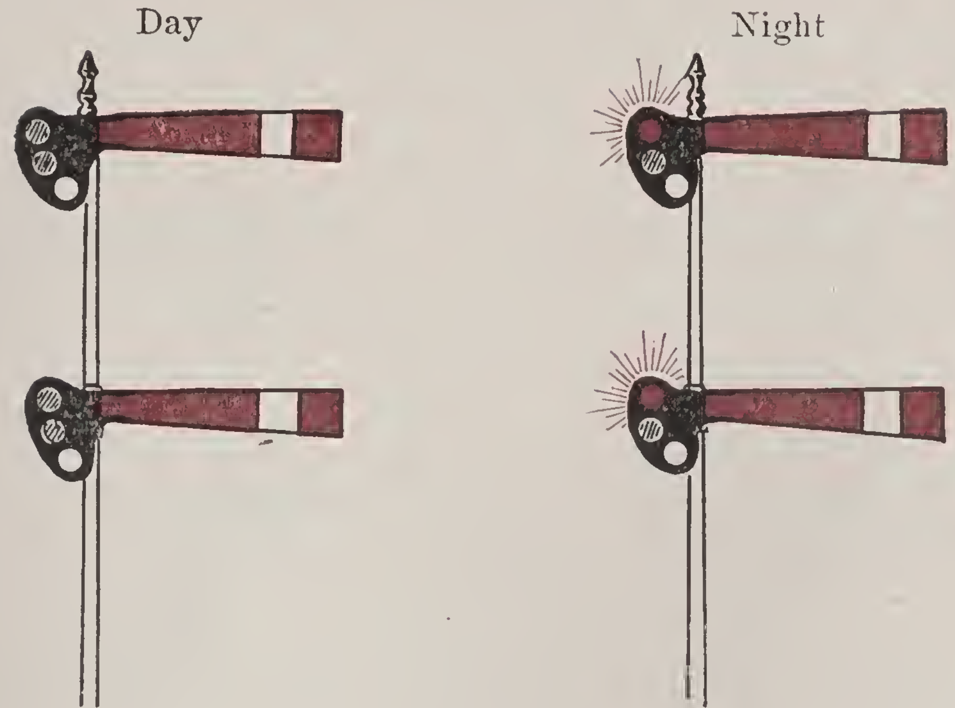


Fig. 29.

Home Signal.

Color—Red light at night. Indication—Stop signal, both main and diverging routes blocked.

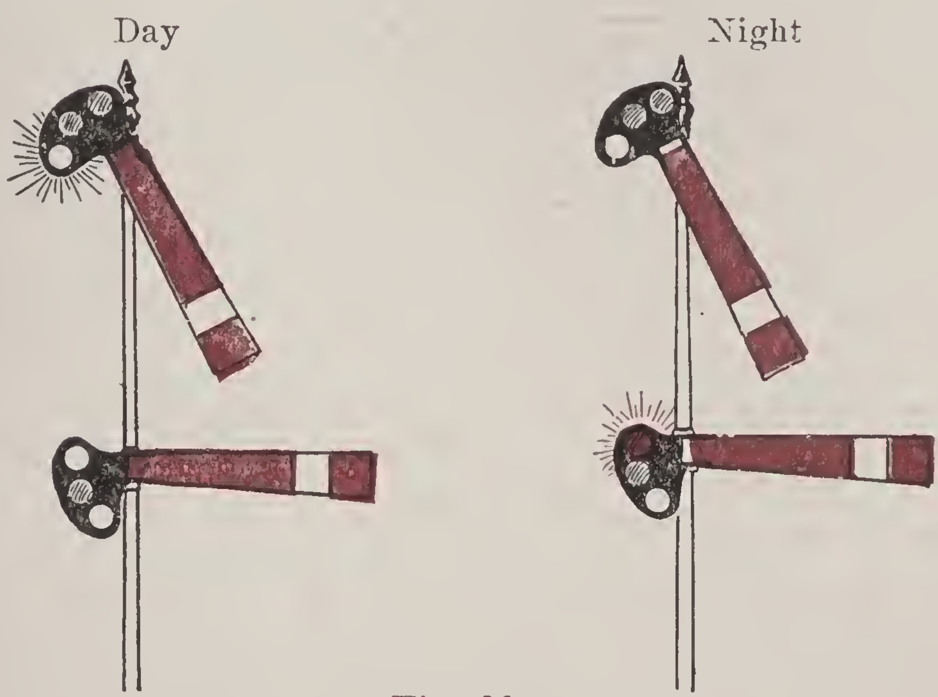


Fig. 30.

Home Signal.

Color—Upper arm White light at night. Lower arm Red light at night. Indication—Main route or high speed route clear. Proceed. Diverging route blocked.

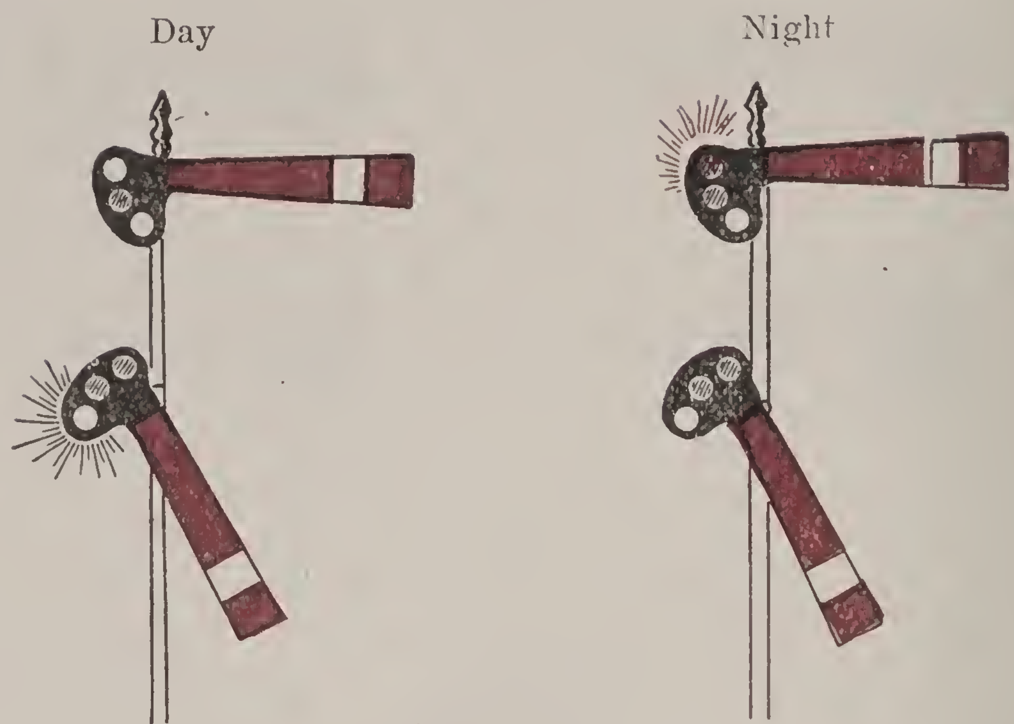


Fig. 31.

Home Signal.

Color—Upper arm Red light at night. Lower arm White light at night. Indication—Diverging route clear, proceed at slow speed. Main route blocked.

Fig. 32.

Dwarf Signal.

Color—Red light at night. Indication—Stop.

Fig. 33.

Dwarf Signal.

Color—White light at night. Indication—Clear signal.

Fig. 34.

Dwarf Signal.

Color—Red light at night. Indication—Stop signal.

Fig. 35.

Dwarf Signal.

Color—Upper arm White light at night. Lower arm Red light at night. Indication—Direct route is clear, proceed.

Fig. 36.

Dwarf Signal.

Color—Upper arm Red light at night. Lower arm White light at night. Indication—Diverging route is clear, proceed.

Fig. 37.

Yard Pot Signals.

Color—White.

Indication—Switch set for main route.

Color—Green.

Indication—Switch set for diverging route.

Fig. 38.

Interlocking Pot Signals.

Color—White.

Indication—Derails closed.

Color—Red.

Indication—Derails open.

Fig. 39.

Home Disk Signal.

Color—Red light at night. Indication—Stop.

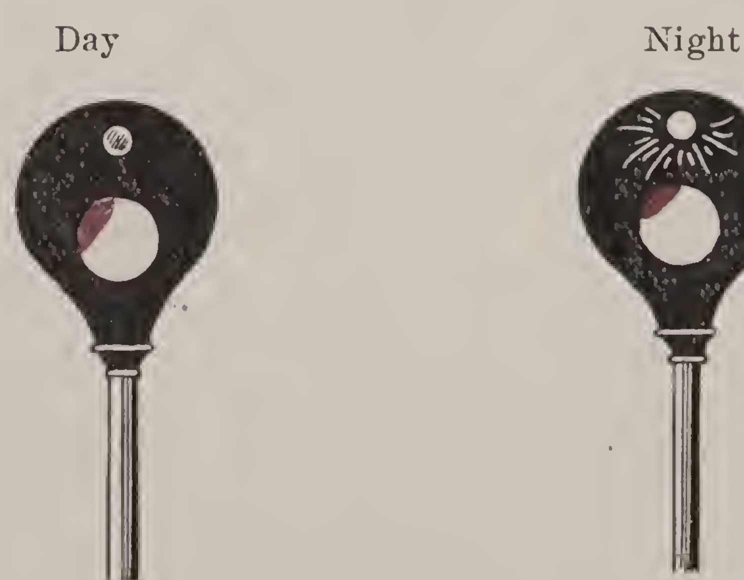


Fig. 40.

Home Disk Signal.

Color—White light at night. Indication—Clear signal.

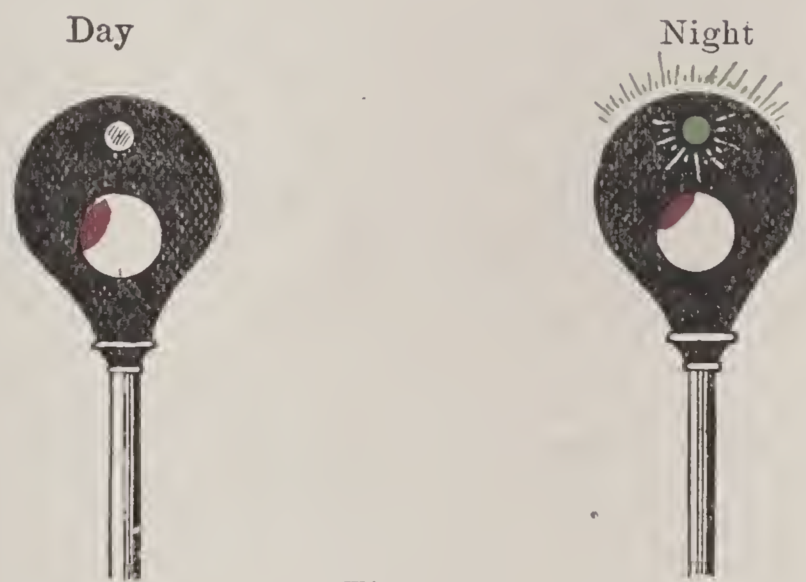


Fig. 41.

Home Disk Signal.

Color—Green light at night. Indication—Clear track.

EXAMINATION QUESTIONS AND ANSWERS ON TRAIN RULES AND TRAIN ORDERS.

Q. What is an engine?

A. A locomotive propelled by any form of energy.

Q. What is a train?

A. An engine or more than one engine, coupled with or without cars displaying markers.

Q. What is a regular train?

A. A train authorized by time-table schedule.

Q. What is a section?

A. One of two or more trains running on the same schedule, displaying signals, or for which signals are displayed.

Q. What is an extra train?

A. A train not authorized by a time-table schedule. It may be designated as:

Extra.....for any extra train except work extra.

Work extra............... for work train extra.

Q. What is a superior train?

A. A train having precedence over other trains.

Q. How may a train be made superior to other trains?

A. By right, class or direction.

Q. How is right conferred?

A. By train order?

Q. Is right superior to class or direction?

A. It is.

Q. How is direction superior?

A. A train given precedence in the direction specified in the time-table as between trains of the same

class, but superiority by direction is limited to single track.

Q. What is a train of superior right?

A. A train given precedence by train order.

Q. What is a train of superior class?

A. A train given precedence by the time-table.

Q. What is a time-table?

A. It is the authority for the movement of regular trains, subject to the rules, and contains the classified schedule of trains with special instructions relating thereto.

Q. What is a schedule?

A. That part of the time-table which prescribes class, direction, number and movement of regular trains.

Q. What is a division?

A. A portion of a railway assigned to the supervision of a superintendent or other superior officers.

Q. What is a subdivision?

A. A part of a division so designated on the time-table.

Q. What is a main track?

A. A track extending through yards and between stations, upon which trains are operated by time-table or train order, or the use of which is controlled by block signals.

Q. What is a single track?

A. A main track on which trains are operated in both directions.

Q. What is a double track?

A. Two main tracks upon one of which the current of traffic is in a specified direction and upon the other in the opposite direction.

Q. How are three (or more) tracks used?

A. Three or more main tracks upon any of which the current of traffic may be in either specified direction.

Q. What is meant by the current of traffic?

A. The movement of trains on a main track in one direction specified by the rules.

Q. What is a station?

A. A place designated on the time-table by name, at which a train may stop for traffic or to enter or leave the main track or from which fixed signals are operated.

Q. What is a siding?

A. A track auxiliary to the main track for the meeting or passing of trains, limited to space the distance between two adjoining telegraph stations.

Q. What is a fixed signal?

A. A signal of fixed location, indicating a condition affecting the movements of a train.

Q. What is a yard?

A. A system of tracks within defined limits, provided for the making up of trains, storing of cars and other purposes, over which movements not authorized by time-table or by train order may be made, subject to the prescribed signals and regulations.

Q. What is a yard engine?

A. An engine assigned to yard service and working within defined yard limits.

Q. What is a pilot?

A. A person assigned to a train when the engineman or conductor, or both, are not fully acquainted with the physical characteristics or running rules of

the road or portion of the road over which the train is to be moved.

Q. What is the duty of conductor and engineman, relative to registering and comparing time?

A. The watches of conductors and engineers must be compared and registered on a prescribed form each trip.

Q. Where conductors and enginemen, whose duties prevent them having access to a standard clock, what do the rules require?

A. They must compare time daily with, and regulate their watches by those of conductors and enginemen, who have standard time and have registered their names as provided by rule. They may, in addition to comparing their watches with other conductors and enginemen, request the time to be sent by the train dispatcher.

Q. What effect does a new time-table have on the preceding one?

A. It supersedes it.

Q. Can a train of the preceding time-table retain its train orders and take the schedule of the train on the new time-table of the same number?

A. When a schedule of the preceding time-table corresponds in number, class, day of leaving, direction, initial and terminal stations with the schedules of the new time-table, a train authorized by the preceding time-table will retain its train orders and assume the schedules of the corresponding number of the new time-table.

Q. Can a train of a new time-table which has not the same number on the preceding time-table, be run

on any division until it is due to start from its initial point on that division after the time-table takes effect?

A. They cannot; schedules on each division (or subdivision) date from their initial stations on such division. Not more than one schedule of the same number and day shall be in effect on any division.

Q. How many times are given for a train at any station?

A. Not more than two times are given for a train at any station.

Q. Where one time is given on a time-table, what does it indicate?

A. Uulless otherwise indicated, it is the leaving time.

Q. Where two times are given, what do they indicate?

A. They are the arriving and leaving time.

Q. Unless otherwise indicated, where does the time shown on time-table apply?

A. The time applies to the switch where an inferior train enters the siding. When there is no siding, it applies to the place from which fixed signals are operated. Where there is neither siding nor fixed signals, it applies to the place where traffic is received or discharged.

Q. What do full faced figures indicate on a time-table?

A. Meeting or passing points of trains.

Q. Are the arriving and leaving times of a train in full-faced type when both are meeting or passing times, or when one or more trains are to meet or pass it between those times?

A. Both the arriving and leaving times of the

train are in full-faced type when both are meeting or passing times or when one or both trains are to meet or pass between those times.

Q. How are registering points designated?

A. Usually by special instructions in the time-table.

Q. What does the letter "s" indicate when placed before the figures of the schedule?

A. A regular stop.

Q. What does the letter "f" indicate?

A. A flag stop.

Q. What does the sign "¶" indicate?

A. A stop for meals.

Q. What does the letter "l" indicate?

A. Leaving time.

Q. What does the letter "a" indicate?

A. Arriving time.

Q. Must employes whose duties require them to give signals provide themselves with the proper appliances and keep them in good order and ready for immediate use?

A. They must provide themselves with proper flagging appliances, keep them in good order and in readiness for immediate use.

Q. What must be used for giving signals by day and night?

A. Flags of prescribed color must be used by day and lamps of the prescribed color by night.

Q. When must night signals be displayed?

A. From sunset to sunrise and when weather or other conditions obscure day signals, night signals must be used in addition.

Q. What does red indicate?

A. A red signal has but one indication—DANGER, STOP.

Q. What does white indicate?

A. Proceed and for other uses prescribed by the rules.

Q. What does green indicate?

A. Proceed with caution, and for other uses prescribed by the rules.

Q. What do green and white indicate?

A. Flag stop; to be used to stop a train only at flag stations, indicated on the schedule.

Q. What does blue indicate?

A. A blue flag by day and a blue light by night, displayed at one or both ends of an engine, car or train, indicates that workmen are under or about it. When thus protected, it must not be coupled to or moved.

Q. Who will display these signals and who will remove them?

A. workmen will display the blue signals and the same workmen are alone authorized to remove them.

Q. May other cars be placed on the same track so as to intercept the view of these signals without first notifying workmen?

A. Other cars must not be placed on the same track so as to intercept the view of the blue signals without first notifying the workmen.

Q. If a fusee is found on or near the track burning red, should it be passed until it is burned out?

A. It should not be passed until it is burned out.

Q. What does a fusee burning green indicate?

A. It indicates caution. When this signal is found, a train may proceed under control, expecting to find the main track blocked.

Q. What does the hand flag or lamp swung across the track indicate?

A. It indicates stop, and when seen between stations, must be answered by two short blasts of the whistle.

Q. Raised and lowered vertically?

A. Proceed.

Q. Swung vertically across the track when a train is standing?

A. It is a signal to back the engine or train.

Q. Swung vertically at arm's length across the track when a train is running?

A. Train has parted. This signal to be repeated until answered by the engineman.

Q. Swung horizontally above the head when train is standing?

A. Apply air brakes.

Q. Held at arm's length above head when train is standing?

A. Release the brakes.

Q. Any object waved violently by anyone on or near the tracks indicates what?

A. Any signal or object waved violently by any person on or near the track is a signal to stop.

Q. What does one short blast of the steam whistle indicate?

A. Apply brakes.

Q. What do two long blasts indicate?

A. Release brakes.

Q. What do one long and three short blasts indicate?

A. Flagman go back and protect the rear of the train.

Q. What do four long blasts indicate?

A. Flagman return from the west or south.

Q. What do five long blasts indicate?

A. Flagman return from the east or north.

Q. What do three long blasts indicate when running?

A. When the train is running, three long blasts of the whistle indicate that the train is parted. This signal must be repeated until answered by trainmen.

Q. What do two short blasts indicate?

A. An answer to any signal not otherwise provided for.

Q. What do three short blasts indicate when train is standing?

A. It is a signal to back the train.

Q. What do four short blasts indicate?

A. A call for signals.

Q. What do one long and two short blasts indicate?

A. To call the attention of yard engines, extra trains or trains of the same or inferior class or inferior right to signals displayed for a following section.

Q. What do two long and two short blasts indicate?

A. Approaching public crossings at grade.

Q. What does one long blast indicate?

A. Approaching stations, junctions and railroad crossings at grade.

Q. What does a succession of short blasts of the whistle indicate?

A. It is an alarm signal for persons or cattle on the track.

Q. What does the explosion of one torpedo mean?

A. It is a signal to stop.

Q. What does the explosion of two torpedoes, not more than two hundred feet, mean?

A. It is a signal to reduce speed and look out for a stop signal.

Q. What do two blasts of the air whistle indicate when the train is standing?

A. It is a signal to start.

Q. Two blasts when train is running?

A. It is a signal to stop at once.

Q. Three blasts when train is standing?

A. It is a signal to back the train.

Q. Three when train is running?

A. It is a signal to stop at the next station.

Q. Four blasts when train is standing?

A. It is a signal to apply or release the air brakes.

Q. Four when the train is running?

A. It is a signal to reduce speed.

Q. Five blasts when the train is standing?

A. It is a signal to call in a flagman.

Q. Five when the train is running?

A. It is a signal to increase the speed of the train.

Q. Must headlights be displayed to the front of every train by night?

A. A headlight should be displayed to the front of every train by night.

Q. When should headlights be concealed?

A. The headlight should always be concealed when a train turns out to meet another and has stopped clear of the main track, or is standing to meet trains at the end of double track or at junctions.

Q. How will yard engines display headlights?

A. To the front and rear by night.

Q. What signals should be displayed on yard engines when not provided with headlights at rear?

A. Two white must be displayed.

Q. Will yard engines display markers?

A. Not when working within defined yard limits.

Q. What signal will be displayed on the rear of every train and what do they indicate?

A. Two green flags, one on each side of the rear of every train, will be displayed as markers to indicate the rear of the train by day; by night, two green lights to the front and sides, and red lights to the rear, except when the train is in clear of the main track, when green lights must be displayed to the front, sides and rear.

Q. What signals are displayed by sections of trains?

A. All sections except the last will display two green flags, and in addition two green lights by night in places provided for that purpose on the front of the engine.

Q. What signals are displayed by extra trains?

A. Extra trains will display two white flags and in addition two white lights, by night in the places provided for that purpose on the front of the engine.

Q. When two or more engines are coupled to a train, which engine shall display the signals?

A. The leading engine only shall display signals.

Q. If one flag or light is displayed wherein the rules prescribe two, what would it indicate?

A. It will indicate the same as two, but the proper display of all train signals is required.

Q. When cars are pushed by an engine (except when shifting or making up trains in the yards) what signals must be displayed on the front of the leading car by night?

A. A white light must be displayed.

Q. How must each car in a passenger train be connected with the engine?

A. Each car must be connected to the engine by a communicating signal appliance.

Q. How must a signal imperfectly displayed or the absence of a signal where a signal is unually shown, be regarded?

A. It must be regarded as a stop signal, and the fact reported to the superintendent.

Q. What signal must be used to stop a train at a point not a flag station?

A. When it is necessary to stop a train at any point that is not a flag station on its schedule, a red signal must be used.

Q. When a signal (except a fixed signal) is given to stop a train, how must it be acknowledged?

A. It should be acknowledged by two short blasts of the whistle.

Q. When must an engine bell be rung?

A. When an engine is about to move and when approaching every public railroad crossing at grade, and kept ringing until the crossing is passed.

Q. When must the whistle be sounded?

A. At all whistling posts, stations, junctions, railroad crossings, at grade, and at other points prescribed by rule or law, or to prevent an accident.

Q. When must watchmen stationed at public roads and street crossings use red signals?

A. Only when necessary to stop trains.

Q. How are trains classified?

A. Trains of the first class are superior to those of the second class; trains of the second class are superior to those of the third class, and so on. Trains in the direction specified by the time-table are superior to trains of the same class in the opposite direction. Extra trains are inferior to all regular trains.

Q. How many hours late must regular trains become to lose both right and class?

A. Regular trains twelve hours behind either their schedule arriving or leaving time at any station lose both right and schedule, and can thereafter proceed only as authorized by the train dispatcher.

Q. At initial stations or junctions, or when passing from double to single track, how can it be ascertained when trains due have arrived and departed?

A. A train must not leave its initial station on any division (or subdivision), or junction, or pass from double to single track without examining the train register to ascertain whether all trains due which are superior or of the same class have arrived or left.

Q. Can a train leave an initial station or junction ahead of an overdue train of the same class in the same direction?

A. When a train of one schedule is on the time of another schedule of the same class in the same

direction, it will proceed on its own schedule. Trains of one schedule may pass trains of another schedule of the same class; extras may pass and run ahead of extras.

Q. How many minutes should an inferior train clear a superior train in the same direction?

A. An inferior train must clear the time of a superior train in the same direction not less than five minutes, and must be clear at the time a first class train in the same direction is due to leave the next station in the rear where time is shown.

Q. If a train fails to clear the main track by the time required by rule, what action must be taken?

A. They must be protected by flag.

Q. What is the rule in regard to trains of the same class at meeting points?

A. At meeting points between trains of the same class the inferior train must clear the main track before the leaving time of the superior train. At meeting points between extra trains the train in the inferior time-table direction must take the siding unless otherwise provided.

Q. What is the rule in regard to trains of different classes at meeting points?

A. The inferior train must take the siding and clear the superior train at least five minutes, and must pull into the siding when practicable. If necessary to back in, the train must first be protected as prescribed by rule unless otherwise provided.

Q. Must a train stop at scheduled meeting or passing points if the train to be met or passed is of the same class unless the switches are right and track clear?

A. Trains must stop unless the switch is right and track clear. When the expected train of the same class is not found at the scheduled meeting point the superior train must approach all sidings prepared to stop until the expected train is met.

Q. Where should a train stop with relation to the switch?

A. Trains must stop clear of the switch used by the train to be met in going in on the siding.

Q. How far apart must trains in the same direction keep?

A. Unless some form of block signals is used, trains in the same direction must keep at least five minutes apart, except in closing up at stations.

Q. Can a train arrive or leave at any station in advance of its schedule arriving or leaving time?

A. A train must not arrive or leave a station in advance of its schedule arriving or leaving time.

Q. If a train overtakes a superior train or a train of the same class that is disabled or cannot proceed, what action should be taken?

A. They will pass it if practicable, and if necessary will assume the schedule and take the train orders of the disabled train, proceed to the next open telegraph station and there report to the superintendent or chief dispatcher.

Q. What will the disabled train do under these circumstances?

A. The disabled train will assume the right or schedule and take the train orders of the last train with which it has exchanged and will, when able, proceed to and report from the next open telegraph office.

When a train, unable to proceed against the right or schedule of an opposing train is overtaken between telegraph stations by an inferior train or a train of the same class, having right or schedule which permits it to proceed, the delayed train may, after proper consultation with the following train, precede it to the next telegraph station, where it must report to the chief dispatcher. When opposing trains are met under these circumstances, it must be fully explained to them by the leading train that the expected train is following.

Q. Can a train display signals for a following section or an extra train be run without orders from the superintendent or chief dispatcher?

A. A train must not display signals for a following section or an extra train be run without orders.

Q. When signals for a section are taken down at any point before that section arrives, what is the conductor's duty?

A. The conductor will, if there be no other provisions, arrange in writing with the operator, or if there be no operator with the switch tender, or in the absence of both, with a flagman left there for the purpose of notifying all opposing inferior trains or trains of the same class leaving such point that the section for which signals were displayed has not arrived.

Q. How must trains approach the end of double track, junctions, railroad crossings at grade and drawbridges?

A. They must be prepared to stop, unless the switches and signals are right and the track is clear. Where required by law, they must stop.

Q. When a train stops or is delayed under circumstances in which it may be overtaken by another train, how must the train be protected?

A. A flagman must go back immediately with stop signals a sufficient distance to insure full protection. When recalled, he may return to his train by first placing two torpedoes on the rail when conditions require it. The front of the train must be protected in the same way, when necessary, by a brakeman or fireman.

Q. Should any freight or extra train at any time be compelled to occupy the main track at a station within ten minutes of the time of any passenger train, what is required?

A. The train should be protected by flag.

Q. If the train should part while in motion, what are the duties of train and enginemen?

A. The train and enginemen must, if possible, prevent damage to the detached portion as prescribed by rule. The detached portion must not be moved or passed until the front portion returns.

Q. When cars are pushed by an engine (except when shifting and making up trains in yards), what precaution must be taken?

A. A flagman must take a conspicuous position on the front of the leading car.

Q. How must messages or orders respecting the movement of trains or conditions of track or bridges be given?

A. They must be given in writing.

Q. How must switches be left after having been used?

A. Switches must be left in their normal position

and must not be left open for a following train unless in charge of a trainman of such train.

Q. In all cases of doubt or uncertainty, what must be done.

A. The safe course must be taken and no risks run.

Q. How are train movements made which are not provided for by time-table?

A. Train orders will be issued by authority and over the signature of the superintendent or chief dispatcher.

Q. Should they contain information or instructions not essential to such movements?

A. They must contain neither information nor instructions not essential to such movements.

Q. Is it proper to make erasures, alterations or interlineations in a train order?

A. They should be made without erasure, alteration or interlineation.

Q. Must train orders be given in the same words to all persons or trains addressed?

A. Each train order must be given in the same words to all persons or trains concerned.

Q. How are train orders numbered?

A. Train orders will be numbered consecutively each day beginning with No. 1 at midnight.

Q. How must train orders be addressed and supplied?

A. To those who are to execute them, naming the place at which each is to receive his copy. Those for a train must be addressed to the conductor and engineman and also to any one who acts as its pilot. A

copy for each person addressed must be supplied by the operator.

Q. Must orders addressed to operators restricting the movement of trains be respected by conductors and enginemen?

A. They must be respected by conductors and enginemen the same as if addressed to them.

Q. How are regular trains designated in train orders?

A. By their numbers, as "No. 10" or "2d No. 10," adding the engine numbers if desired.

Q. How are extra trains designated in train orders?

A. By engine numbers and the direction, as "Extra 798 east or west."

Q. Who will sign train order form "31"?

A. Those to whom the order is addressed, except enginemen, must sign it.

Q. After the train order has been signed by those addressed, what is necessary before acting on same?

A. The response "complete" and the time, with initials of the superintendent or chief dispatcher, must be given by the train dispatcher. The copy for the engineman should be delivered to him personally by the conductor.

Q. Who will sign train order form "19"?

A. When a "19" order has been repeated correctly by an operator, the response "complete" and the time, with initials of the superintendent or chief dispatcher will be given by the train dispatcher. The operator receiving this response will then write on each copy the word "complete," the time and his last name in

full, and personally deliver a copy to each person addressed, without taking his signature.

Q. If a train order has been repeated or the "X" response sent but has not be made "complete," how should the order be treated?

A. The order must be treated as a holding order for the train addressed, but must not be otherwise acted on until "complete" has been given.

Q. If the line fails before an office has repeated an order or has sent the "X" response, how should such an order be treated?

A. The order for that office is of no effect and must be treated as if it had not been sent.

Q. How should an order be addressed and handled to be delivered to a train at a point not a telegraph station or at one at which the telegraph office is closed?

A. The order must be addressed to the conductor and engineman at the station where the order is to be delivered in care of the conductor of the train delivering the order. When form "31" is used, "complete" will be given upon the signature of the person by whom the order is to be delivered, who must be supplied with copies for the conductor and engineman addressed and a copy upon which he shall take their signatures. This copy he must deliver to the first operator accessible, who must preserve it and at once transmit the signatures of the conductor and engineman to the train dispatcher.

Q. How will trains so receiving this order treat the same?

A. The orders so delivered must be acted on as if "complete" had been given in the usual way.

Q. When a train is named in a train order, are all its sections included?

A. When named by its schedule number alone, all sections of that schedule are included and each must have copies of the order delivered to it.

Q. How long do train orders remain in effect?

A. Train orders once in effect continue so until fulfilled, superseded or annulled.

Q. Can any part of an order specifying a particular movement be superseded or annulled?

A. Any part of an order may be either superseded or annulled.

Q. Do train orders held by or issued for a regular train become void when such train loses both right and schedule or is annulled?

A. Orders held by or issued for any part of an order relating to a regular train become void when such train loses both right and schedule or is annulled.

Q. What signal is used at a train order office, and what should be its normal position?

A. A fixed signal is used at each train order office, which shall indicate "stop" when there is an operator on duty, except when changed to "proceed," to allow a train to pass after getting train orders or for which there are no orders.

Q. While "stop" is indicated, can a train proceed?

A. A train must not pass the signal while "stop" is indicated.

Q. If a signal at a night telegraph office is not displayed at night and trains have not been notified, what action should be taken?

A. Trains must stop and ascertain the cause and report the facts to the superintendent from the next open telegraph office.

Q. What are the indications of the train order semaphore arm?

A. The arm indicates "stop" when horizontal, and "proceed" when in an inclined position.

Q. What signs and abbreviations may be used?

A. The signs and abbreviations used in train service are:

Initials for the signature of the superintendent or chief dispatcher
C. & E. for conductor and engineman.
Com. for complete.
No. for number.
Eng. for engine.
Sec. for section.
Psgr. for passenger.
Frt. for freight.
Mins. for minutes.
Jct. for junction.
Opr. for operator.

The usual abbreviations for the name of the months and stations.

Q. How should train orders read fixing meeting points for opposing trains?

A. No 1 meet No. 2 at "B."
No. 3 meet second No. 4 at "B."
No. 5 meet extra No. 95 east at "B."
Extra 652 north meet extra 231 south at "B."

Q. How will these trains receiving orders govern themselves?

A. They will run with respect to each other to the designated points, and there meet in the manner provided by the rules.

Q. How should train orders read directing trains to pass or run ahead of another train?

A. *(1) No. 7 pass No. 3 at "K" and run ahead of No. 7 "M" to "Z."*

(2) No. 2 pass No. 4 when overtaken.

(3) Extra 594 east run ahead of No. 6 "M" to "B."

(4) Extra 95 west run ahead of No. 3 "B" until overtaken.

Q. How will trains receiving these orders govern themselves?

A. Both trains will run according to rule to the designated point, and there arrange for the rear train to pass promptly. When a train is to pass another when overtaken, trains will run according to the rule until the train is overtaken and there arrange to pass promptly. When an inferior train receives an order to pass a superior train, right is conferred to run ahead of the train passed from the designated point.

Q. How should orders read giving a train right over an opposing train?

A. *(1) No. 1 has right over No. 2 "G" to "X."*

(2) No. 37 east has right over No. 3 "F" to "A."

Q. What should trains do having these orders?

A. This order gives the right to the first named train over the other train between the points named. If the trains meet at either of the designated points, the first named train must take the siding, unless the order otherwise prescribes. Under order (1), if the

second named train reaches the point last named befor the other arrives, it may proceed, keeping clear of the opposing train as many minutes as such train was before required to clear it under the rules. Under order (2), the regular train must not go beyond the point last named until the extra train has arrived, unless directed by train order to do so.

Q. What is the form of a time order?

A. *(1) No. 1 run 20 mins. late "A" to "G."*

(2) No. 1 run 20 mins. late "A" to "G" and 15 mins. late "G" to "K."

(3) No. 1 wait at "H" until 10 a. m. for No. 2.

(4) No. 3 wait at "N" until 11:00 a. m.
"P" until 14:30 a. m.
"R" until 14:55 a. m.

Q. What rights would the train have receiving this order?

A. Orders (1) and (2) make the schedules of the train named between stations mentioned as much later as stated in the order. Under order (3), the train first named must not pass the designated points before the time given, unless the other train has arrived. Under order (4), the train named must not pass the designated points before the times given. Other trains receiving the order are required to run with respect to the time specified at the designated point or any intermediate station where schedule time is earlier than the time specified in the order, as before required to run with respect to the schedule time of the train named.

Q. What form of an order is used for sections?

A. *(1) Eng. 20 display signals and run as 1st No. 1 "A" to "Z."*

(2) Eng. 25 run 2d No. 1 "A" to "Z."
(3) No. 1 display signals "A" to "G" for eng. 65.
(4) 2d No. 1 display signals "B" to "E" for eng. 99.

Or the orders may be modified as follows:
Engs. 20, 25 and 99 run 1st, 2d and 3d No. 4 "A" to "Z."

Order No. 1 is used when the number of the engine for which signals are displayed is unknown and is to be followed by order No. 2, both being single orders. Under order No. 2 the engine named will not display signals. Under order No. 4 the engine last named will not display signals.

Q. What form of orders are used to add an intermediate section?

A. *Eng. 85 display signals and run as 2d No. 4 "N" to Z." Following sections change numbers accordingly.*

Under this order, engine 85 will display signals and run as directed, and following sections will take the next higher number.

Q. What form of an order should be used to drop an intermediate section?

A. *Eng. 84 is withdrawn as 2d No. 1 at "H." Following sections will change numbers accordingly.*

Under this order engine 85 will drop out at "H," and the following sections will take the next lower number.

Q. What form of an order is given when engines are changed?

A. When one engine is changed for another on a section, the order should read

Eng. 18 instead of eng. 85 display signals and run as 2d No. 1 "R" to "Z."

Under this order, engine 85 will drop out at "R" and engine 18 will run as directed.

Q. What form of an order is given to discontinue the display of signals?

A. The order should read

2d No. 1 take down signals at "D."

Under this order No. 1 will take down signals as directed, and a following section must not proceed beyond the point named.

Q. What form of an order is given to reverse the positions of sections?

A. The order should read

Engs. 99 and 25 will reverse positions as 2d and 3d No. 4 "H" to Z."

Under this order, engine 99 will run ahead of engine 25 "H" to "Z." If necessary, both engines will arrange signals accordingly.

Q. What form of order is used for extra trains?

A. *(1) Eng. 98 run extra "A" to "F."*

(2) Eng. 99 run extra "A" to "F" and return to "C."

Under order No. 2 the extra must go to "F" before returning to "C."

Q. What form of an order should be used giving an extra schedule time?

A. *Eng. 77 run extra leaving "A" on Thursday, Feb. 17th, as follows, with right over all trains:*

Leave "A" 10:30 p. m.
Leave "C" 12:25 a. m.
Leave "E" 1:47 a. m.
Leave "F" 2:22 a. m.

Trains over which the extra is given right must clear the time of the extra at least five minutes.

Q. What form of orders is used for work trains?

A. (1) *Eng. 292 works 7 a. m. to 6 p. m. between "D" and "E."*

Under this order the work extra must, whether standing or moving protect itself against extras within the working limits in both directions. The time of regular trains must be cleared, or the order may be modified by adding

(2) *Not protecting against (eastward) extras.*

(3) *Not protecting against extras.*

Under order No. 2, the work extra will protect only against (westward) extras. Under order No. 3, protection against extras is not required. The time of regular trains must be cleared.

Q. What provisions can be made to run an extra over the work train limits?

A. An order should be given as follows:

Work extra 292 clears (or protects against) extra 76 east between "D" and "E" after 2:10 p. m.

Under this order, extra 76 east must not enter the working limits before 2:10 p. m., and will then run expecting to find the work extra clear of the main track (or protecting itself), as the order may require.

Q. If an order should be given as follows:

Work extra 292 will protect against No. 55 between "D" and "E."

how should the train be handled.

To enable a work extra to work upon the time of any regular train, the order should read

Work extra 292 protects against No. 55 between "D" and "E."

Under this order, the work extra may work upon the time of the train mentioned in the order, and must protect itself against such train as described by rule. The regular train receiving the order will run expecting to find the work extra protecting itself.

Q. What form is used for a holding order?

A. *Hold No. 2.*

Hold all (or ———ward) trains.

When a train is held under this order, it must not proceed until the order to hold is annulled or an order given to the operator as follows:

No. 2 may go or No. — may go.

These orders will be addressed to the operator, and will be delivered to conductors and enginemen of all trains affected.

Q. What form of order is used for annulling a regular train?

A. *No. 1 of Feb. 29th is annulled "A" to "Z."*

2d No. 5 of Feb. 29th is annulled "E" to "G."

Under this order, the schedule of the section annulled becomes void between the points named and cannot be restored.

Q. What form of order is used for annulling a train order?

A. *Order No. 10 is annulled.*

Q. What form of order is used for annulling a part of a train order?

A. *That part of order No. 10 reading No. 1 meet No. 2 at "S" is annulled.*

Q. What form of order is used for superseding a train order or part of a train order?

A. *(1) No. 1 meet No. 2 at "C" instead of "B."*
(2) No. 1 has right over No. 2 "G" to "R" instead of "X."
(3) No. 1 display signal for eng. 85 "A" to "Z" instead of "G."

An order which has been superseded cannot be reissued under its original number.

Q. Are all of the rules for single track applicable to two or more tracks?

A. Only a part of the single track rules are applicable to double track.

Q. How are the rules, which differ in language or are applicable to double track only, distinguished?

A. In the code of train rules for double track they are marked with a letter "D"; rules which do not apply to double track are marked "omitted."

Q. Are all rules in the single and double track codes which are not marked "D" or "omitted" the same for both single and double tracks?

A. They are the same, and are used on both single and double track roads.

Q. When using double track, and a train crosses over or obstructs the other track, what precaution must be taken?

A. Unless otherwise provided, it first must be protected by a flag in both directions on that track.

Q. What precautions must be taken on double track, or three or more tracks, when a train meets or passes a passenger train at stations?

A. They must use caution and must not pass between it and the platform at which passengers are being received or discharged.

Q. How are trains governed when running with the current of traffic on double track by means of block signals?

A. On portions of the road so specified on the time-table, trains will run with the current of traffic by block signals whose indications will supersede time-table superiority.

Q. How are trains on two or more tracks supervised when moving by means of block signals?

A. They will be supervised by the superintendent or train dispatcher, who will issue instructions to signalmen when required.

Q. When a train has work to do between block stations that will consume more than five minutes, what action must be taken before leaving the last block station?

A. They must obtain permission from the signalman at the last block station at which there is a siding before entering the block in which the work is to be done.

Q. Is this permission granted by authority of the signalman?

A. It is not; the signalman must obtain authority to give his permission from the superintendent or train dispatcher.

Q. How is the movement of trains governed when running against the current of traffic on double track by means of block signals?

A. On portions of the road so specified on the time-table, trains will run against the current of traffic by block signals whose indications will supersede time-table authority and will take the place of train orders.

Q. By whom is the movement of trains supervised

when running against the current of traffic?

A. The movement will be supervised by the superintendent or train dispatcher, who will issue instructions to the signalman.

Q. When using three or four tracks, how are the tracks designated?

A. One of the main tracks will be designated as No. 1; additional tracks will be numbered therefrom, even numbers to the right, odd numbers to the left, when facing east or north.

Q. How is the use of these tracks designated?

A. They are designated both as to the class and current of traffic on the time-table or by special instructions.

Q. What signals are displayed by night when a train is running with the current of traffic on a high-speed track?

A. They will display two red lights to the rear.

Q. When a train is running by night with the current of traffic on a slow speed track or a train by night using a track against the current of traffic, what signals will be displayed on three and four-track roads?

A. They will display a green light to the rear on the side next to the high-speed track in the direction of the current of traffic, and a red light on the opposite side.

Q. How are engine whistle signals distinguished when given for the purpose of calling in a flagman on three or more track roads?

A. They are distinguished by a code of signals which apply to each individual track, such as five long blasts for a flagman on track No. 1 to return from the rear; one short and five long blasts for flagman on

track No. 1 to return from the front; four long blasts for flagman on track No. 2 to return from the rear; one short and four long blasts for flagman on track 2 to return from the front; five long and one short blasts for the flagman on track No. 3 to return from the rear; one short, five long and one short blasts for flagman on track No. 3 to return from the front; four long and one short blasts for flagman on track No. 4 to return from the rear; one short, four long and one short blasts for flagman on track 4 to return from the front.

AIR BRAKE INSTRUCTIONS.

PART II.

The Air Brake instructions illustrated and described herein are for the purpose of educating conductors and trainmen more thoroughly in the use and operation of the air brake appliances attached to passenger and freight equipment. They cover all of the different parts of the air brake and air signal system, including the new improved Westinghouse type "K" triple valve, their functions, the relation they bear to one another, and the manner of their operation is thoroughly explained. It is essential that employes in the train service should qualify themselves in modern air brake practice, especially so far as it relates to the parts with which they come in contact daily. Conductors and trainmen should familiarize themselves with the interior and exterior parts of the triple valve, retainers, signal valve, and other equipment, in order that they may more readily locate defects and be better able to overcome air brake troubles between terminals. A knowledge of the operation of the air brake equipment attached to the engine is a valuable asset to a trainman, but they should first become thoroughly posted on the operation of the parts connected to passenger and freight equipment.

DEFINITION OF THE AIR BRAKE.

An air brake is a power brake operated by compressed air.

An automatic air brake is a form of power brake automatically applied when a sufficient reduction is made in the air pressure in the brake pipe to cause the triple valve to move from release to service position, and released when the pressure in the brake pipe is increased above auxiliary pressure.

TRACING AIR THROUGH THE BRAKE EQUIPMENT.

The course of the air through the brake equipment is as follows: Air enters the brake pipe through the cut-out cock below the brake valve, through the hose and couplings to the first closed angle cock in the train, and to the conductor's valve of each coach and way car, through the cross-over pipe and cut-out cock to the triple valve, and through the feed grooves of the triple valve, when in release position, to the auxiliary reservoir, charging the latter. When a sufficient reduction is made at the brake valve, or from the brake pipe, it will cause the auxiliary reservoir pressure to feed to the brake cylinder, thus applying the brake. Restoring the brake pipe pressure above that in the auxiliary reservoir, or reducing the auxiliary pressure below that in the brake pipe, will cause the triple valve to move to release position, allowing the air in the brake cylinder to pass to the atmosphere through the triple exhaust and retainer.

STORAGE OF PRESSURES.

The compressed air used on the train is stored in the brake pipe, auxiliary reservoirs, and signal line.

Brake pipe pressure is stored in the brake pipe, and is used to charge and recharge the auxiliary reservoirs, apply and release the brakes, and assist in applying the brakes in emergency applications with the old type quick action triple, and in service and emergency applications with the "K" triple valve.

Auxiliary pressure is stored in the auxiliary reservoirs; its duty is to hold the slide valve to its seat, operate the quick action parts of the triple, set the brake and also to charge the water pressure on tourist cars that are so equipped.

Signal line pressure is stored in the signal line and in Chambers A and B of the signal valve. It is used to transmit signals from tarinmen to enginemen.

BEGINNING AND ENDING OF PRESSURES.

Brake pipe pressure begins on the brake pipe side of the feed and excess pressure valves, and ends underneath the brake pipe side of the equalizing piston, the first closed angle cock in the train, the conductor's valve of the coach or way car, the brake pipe side of the triple piston and in chamber Y.

Auxiliary pressure begins at the auxiliary side of the triple piston and ends in the auxiliary reservoir, the water pressure governor of Pullman and tourist cars, and the face of the slide valve.

Signal line pressure begins at the signal line side of the signal reducing valve and ends at the first turned cut-off cock in the train, at the car discharge valves of the coaches and in chambers A and B of the signal valve.

BRAKE PIPE PRESSURES.

A brake pipe pressure of 70 pounds should be carried with the ordinary brake, and 110 pounds with the high speed brake.

EXCESS PRESSURE.

Excess pressure is the amount of pressure carried in the main reservoir over and above that in the brake pipe. It should be carried at all times, except when chargng a train at terminals or recharging while descending heavy grades, and it should be carried then if practicable.

Purposes of Excess Pressures. Excess pressure is carried to insure a prompt and certain release of all brakes, especially with long trains, to insure a quick recharge of the brake pipe and auxiliary reservoirs, and to operate the different appliances on the locomotive that are operated by main reservoir pressure without affecting the brake pipe pressure.

A greater excess pressure is carried on freight than on passenger trains, for the reason that on freight or long trains there is a greater volume of air to control, a larger number of auxiliary reservoirs to recharge and it is more difficult to release the brakes than on a short train.

EQUALIZATION OF PRESSURES.

Brake pipe and auxiliary reservoir pressures are equal when both are charged and in lap position of the brake valve, but they are not the same when charg-

ing, applying or releasing the brakes, in an over-reduction or in an emergency application.

SOURCES OF AIR TO BRAKE CYLINDERS WITH DIFFERENT TYPES OF TRIPLE VALVES.

The air that enters the brake cylinder passes from the auxiliary reservoir in service applications, from both the brake pipe and the auxiliary reservoir in an emergency application with the quick action triple, and from the brake pipe and auxiliary reservoirs in service and emergency applications with the "K" type triple valve.

BRAKING POWER.

The braking power is dependent largely on the piston travel. The shorter the piston travel, the greater the braking power, and the higher the pressure at which the auxiliary reservoir and brake cylinder pressure will equalize; the longer the piston travel, the lower the pressure at which they will equalize, and the weaker the braking power.

With the same piston travel the holding power of the brakes will be alike on empty and loaded cars, but the empty car will be brought to a stop in less distance than the loaded car, as the brakes must overcome the greater weight, in addition to the momentum of the loaded car.

AIR BRAKE EQUIPMENT—FREIGHT.

The different devices or appliances which are required to complete the air brake equipment on a

freight car are as follows: Quick action triple valve, brake pipe, hose, angle cock, cross-over pipe, cut-out cock in the cross-over pipe, auxiliary reservoir, brake cylinder and retainer with pipe connections leading to the triple exhaust, brake rigging, and hand brake connections.

On freight cars the brake pipe is attached to the center sills running lengthwise underneath the body of the car. Each end of the brake pipe is equipped with an angle cock. A short section of hose with couplings and connections attached are joined to the angle cock connections. The cross-over pipe leads from the brake pipe to the triple valve, which is placed underneath and near the center of the car. The auxiliary reservoir and air brake cylinder are placed adjacent to each other and are also connected with the triple valve. The pressure retaining valve is placed at the end and near the top of the car close to the wheel of the hand brake. The bleed cock is attached to the auxiliary reservoir and is operated by means of rod connections which lead to the sides of the car.

AIR BRAKE EQUIPMENT—PASSENGER.

Passenger cars are equipped with practically the same devices as freight equipment, with the following additions: Signal line, car discharge valve, high speed reducing valve, conductor's valve, and on Pullman and tourist cars the water pressure valve. The automatic slack adjuster is used to some extent on passenger equipment.

Nearly all of the parts or devices that combine to form the passenger air brake equipment are placed in

the same relative positions underneath the body of the car that they occupy on freight cars. The conductor's valve is usually placed in the toilet room, and is connected by a cord extending the entire length of the coach. The car discharge valves are placed on the ends of the car just above the door on the inside of the car, and are connected by means of a cord extending the entire length of each car, so that they may be operated from any part of the car. The high speed reducing valve is connected to the brake cylinder by pipe connection; the triple valve is attached direct to the brake cylinder, the auxiliary reservoir and the brake cylinder are placed a short distance apart, joined with a short section of metal pipe.

Cut-Out Cocks. The cut-out cock is placed in the section of pipe that leads from the brake pipe to the triple valve. It is used for the purpose of cutting out a brake which may have become defective.

Positions of Cut-Out Cock. To place the air brake mechanism of a car in service the handle of cut-out cock should be placed at right angles with the cross-over pipe to which it is connected. The brake is then cut in. To cut out the air brake mechanism from the brake pipe, place the handle in a position parallel with the cross-over pipe. This prevents the air from flowing to and charging the auxiliary reservoir. The positions are indicated by grooves in the cut-out plug, showing the position of the valve openings.

Angle Cock Positions. The handle of the angle cock should be parallel with the brake pipe when in service, and should be placed at right angles with the brake pipe when cut out, which respective positions are indicated by the grooves cut in the plugs.

Signal Line Cut-Out Cock. The position of the cut-out cock in the air signal line is parallel with the pipe when cut out, and at right angles with the signal pipe when in service, as indicated by the grooves showing the valve openings. The cut-out cock in the branch pipe leading from the signal pipe is so located that the car discharge valve may be removed and cleaned while the signal line is charged, and for the further purpose of cutting out the valve if it becomes defective.

Conductor's Valve. The conductor's valve is connected to the brake pipe and is used by trainmen for the purpose of applying brakes in an emergency.

COUPLING AIR HOSE.

Before coupling an engine to a train the brakeman should slightly open the angle cock on the engine tender, thus permitting the air pressure to blow out any dirt or foreign matter which may have accumulated in the hose. He must also see that he gets a good blast of air from the hose, which will indicate that the pressure in the pipe is normal. The brakeman or inspector will then couple up the hose connections to the brake and the air signal pipes, and gradually open the angle cocks on the engine. It should be understood, however, that the train couplings must be made before the air lines are coupled.

CHARGING AUXILIARY RESERVOIRS.

Time Consumed in Charging. With a constant pressure of 70 pounds in the brake pipe, the auxiliary reservoirs of short trains should charge in about 70

seconds, but, owing to clogged strainers, feed grooves, the difference in size of feed grooves and the capacities of auxiliary reservoirs, it ordinarily takes from 2 to 2 1-2 minutes, and on long trains from 5 to 10 minutes. Trainmen should bear this in mind when charging the train at a terminal, when adding cars to the train, and before testing the brakes.

Failure of Auxiliary to Charge. The failure of the auxiliary reservoir to charge or to become charged slowly may be due to several causes, among which are the following: Feed grooves that are wholly or partly stopped up, strainer at the triple valve or the strainer in a cross-over pipe becoming partly or wholly clogged, a cut-out cock partially closed, or a bad leak in the auxiliary reservoir.

AIR BRAKE TESTS.

Terminal Tests—Freight Trains. Before starting on a trip the air brakes should be tested, which is the joint duty of the engineman and the trainmen.

The brakeman should open the angle cock on the tender and note whether a good blast of air is secured before making the hose coupling to the engine, and then couple up the hose and open the angle cock gradually.

While the train is being charged the brakeman should pass alongside of it, inspecting the brake rigging and noting whether there are any brake pipe or auxiliary leaks; if any are found they should be remedied; if defective hose or gaskets are found they should be replaced with new ones.

When the train is charged and the engineman and trainmen are satisfied that the brake system is reason-

ably free from leaks, the rear brakeman, stationed at the rear air car, should transmit the signal "apply air brakes" to the head brakeman, who should repeat the signal to the engineman, who will make a 25-pound brake pipe reduction, and then place the brake valve in lap position. The engineman should also note the length and strength of the brake pipe exhaust, which will indicate whether any triple applied in quick action, the length of the brake pipe and whether there is a partly closed angle cock or an obstruction in the brake pipe.

After a full reduction has been made by the engineman thus applying the brakes it is the duty of the head and rear brakemen to walk toward one another, inspecting the brake on each car to see that it applies and holds, noting the piston travel, and looking for brake pipe, cylinder and auxiliary leaks. When the brakemen meet they should signal the engineman to release the brakes, and then return to their respective ends of the train, noting that all brakes have released and that no shoes are frozen to the wheels in cold weather. If any brake fails to release or is otherwise defective it should be cut out, carded and the auxiliary reservoir drained of its air. After reaching their respective ends of the train the brakemen should notify the conductor of the condition of the train brakes and the number of cars in working order. The conductor should then in turn notify the engineman of the condition of the brakes, the number of loads and empties, their location in the train and the amount of tonnage, so that the engineman can use his judgment accordingly when using the brakes.

Terminal Tests—Passenger Trains. During the

time the train is charging, the trainman or inspector will pass alongside the train, carefully examining all of the air brake-equipment, especially at connections, for leaks. He should enter each coach and test each car discharge valve to see that it is working properly. After the brake pipe and auxiliary reservoirs are fully charged, the brakeman or inspector should give four distinct blasts of the air whistle, and also the hand signal to the engineman to apply the brakes. He will then walk to the rear of the train, inspecting all brakes by noting the position of the piston in the brake cylinder, and examining the brake rigging. After reaching the rear of the train, he will pull the car discharge valve four times, this being the signal to the engineman to release brakes. When the brakes have been released, the brakeman or inspector will pass alongside the train toward the engine, noting whether all brakes are released by the pistons returning to their normal position.

Inspect All Brakes. When making a thorough test the brakes must be held set until the trainmen have sufficient time to inspect all the brakes thoroughly. The longer a brake remains applied the more certain trainmen can be that it will hold for a long, hard stop. A brake that will not remain applied for a minute or longer is considered a poor brake and should be carded.

Emergency Applications Not to Be Made When Testing. Emergency applications must not be made when testing brakes, for the reason that ordinary braking should not be done in this manner as it causes an unnecessary strain on the brake rigging, and it will be impossible to detect any defective triple valve in the train, as some brakes would set in emergency that

would not set in a service application. It would also cause a waste of brake pipe air, making it difficult to release the brakes.

Running Test. When a train leaves its terminal or a change is made in the make-up of a train, the conductor should insist on the engineman making a running test of the brakes after the train has moved a train length. As soon as the brakes are felt to take hold they should be released. This not only assures the engineman and train crew that the brakes are cut in, but also indicates how they act and hold:

This test should be repeated when engines are changed, adding a double header, after long delays at any point on the road, when air cars are added to or set out from the train, when the engine is cut off and when the train is cut at a crossing. The head brakeman should make the terminal test on cars picked up, while the rear brakeman or the conductor should see that the brakes on the rear air cars are applied and released from the engine.

Two-Mile Test. Conductors should insist on the two mile running test being made before descending heavy grades and when approaching terminals, meeting points, railroad crossings, junction points, interlocking plants, ends of double tracks and other dangerous places where a stop may be required. This test is made by making a sufficient reduction of brake pipe pressure on freight trains to raise the equalizing piston with a 3 or 4-pound reduction, and noting the length and strength of the brake pipe exhaust. On passenger trains a 10-pound reduction should be made and the engineman should feel the brakes take hold, in addi-

tion to noting the length and strength of the brake pipe exhaust, and then release the brakes.

Cutting Out Brakes. If the engineman cannot release the brakes on a car by the use of the brake valve, the brakeman must turn the cut-out cock to a position parallel with that of the cross-over pipe. This prevents the air in the brake pipe from reaching the triple and auxiliary reservoir. The auxiliary reservoir still being charged and the brakes applied, the air must be released from the auxiliary, by opening the bleed cock on the reservoir. The employe making the test must then fill out and attach a card specifying the defects.

Brake Pipe Leaks. Any leak found in the brake pipe should be remedied. If the leak is found in the hose and it cannot be repaired, it should be replaced with a new hose. If the leak is in the coupling, it may be due to a worn or defective gasket, which should be replaced with a new one. If the hose coupling is loose, insert a piece of wood back of the jaws to hold the couplings together.

DEFECTIVE TRIPLE VALVE.

A dry or dirty condition of the triple valve will usually cause it to assume the emergency position when a service application of the brakes is made by the engineman. This is caused by the defective triple valve failing to respond to the first, and at times to the second service reduction in the brake pipe pressure. On the next reduction the difference between the brake pipe pressure and that contained in the auxiliary reservoir is so great that the triple piston is

suddenly started from its release position and moves its full length of travel, causing an emergency application of the brakes.

Locating Defective Triples by Sectional Tests. If the brakes on a car apply in the emergency during a service reduction in the brake pipe, the car should be located by means of a sectional test and then cut out by means of the cut-out cock in the cross-over pipe. The auxiliary reservoir should be bled by means of the bleed cock, thus releasing the air from the auxiliary reservoir and also releasing the brakes. A card showing the nature of the defect should then be attached to the car. The method of making a sectional test is as follows: Assuming that the train consists of seventy cars and a triple valve on a car becomes defective, causing the brakes to apply in the emergency when a service reduction in the brake pipe has been made by the engineman, the angle cock should be turned twenty cars from the engine, thus preventing the release or application of the brakes on the rear cars. The engineman should then make a service reduction. If quick action of the brakes is not produced it indicates that the defective triple valve is in the rear portion of the train, and the angle cock behind the twenty cars should be opened, allowing the air pressure to flow throughout the train, recharging the auxiliaries. It will then be necessary to close the angle cock of the fortieth car from the engine and repeat the tests. If the brakes apply in the emergency it would show that the defective triple valve is located in the second section of the twenty cars. A signal will then be given by the engineman to release the brakes and recharge the brake pipe and auxiliary reservoirs, then making a sufficient

reduction to cause the pistons in the brake cylinders to move past the leakage grooves. An inspection will show on what car of the second twenty the brakes have not applied. When this car has been found the engineman should make a further reduction, and if the brakes go into quick action, the car should be cut out by means of the cut-out cock in the cross-over pipe. If the defective triple cannot be located in the manner above described, divide the sections into eight or ten cars instead of twenty, and proceed in the same manner.

DEFECTIVE BRAKE PIPE.

A freight car having a broken or defective brake pipe should be switched to the rear of the train, and the angle cock turned at its front end, thus cutting out the air from the defective portion.

Defective Passenger Brake Pipe. In the event of a broken brake pipe on a passenger car, the car may be left in its position in the train. The signal air pipe of this car should be connected with the brake pipe of the car ahead and the car behind by means of short hose sections, which form a part of the train equipment. These hose sections are provided with a brake pipe connection on one end and a signal line coupling on the opposite end. The brakes on the car which is connected in this manner cannot be operated as the air is cut off from the auxiliary reservoir and brake cylinder. The air signal can be used only on cars ahead of the one so connected.

TRANSMITTING SIGNALS WITH CONDUCTOR'S VALVE.

If it becomes necessary to transmit a signal to the engineman from the cars behind the one connected in the manner explained in the foregoing paragraph, it may be done by making a slight reduction in the air pressure in the brake pipe, using the conductor's emergency valve. The engineman should be notified that the signal line is out of service and that the conductor's valve will be used in cases of necessity. Care must be taken not to set the brakes in emergency when using the conductor's valve for transmitting signals. This method of using the signal line temporarily when the train line is defective is preferable to switching the car to the rear of the train, which would cause loss of time and would disarrange the order of the cars in the train. Any change in the regular make-up of a passenger train will result in delays and annoyance.

TRAIN PARTING.

If the train breaks in two in the air connections, the brakeman should, after the train has come to a stop, turn the angle cock on the rear car of the first section ahead of the broken part, signal the engineman to release the brakes, and then couple-up to the rear section. The air connection must then be made, and the engineman will release the brakes on the entire train. After the brake pipe and auxiliaries are fully charged, a test must be made to see that the brakes on the head and rear cars apply and release.

NUMBER OF AIR CARS IN TRAIN.

All working air brake cars in a train should be in service and must represent at least 75 per cent. of the total number of cars in the train.

By making a five or six pound reduction an engineman can tell approximately how many cars are coupled up by the length and strength of the brake pipe exhaust, but he cannot tell how many cars are cut in or working.

CARS SET ON SIDINGS.

When a car is placed on a siding, the air should be drained from the brake pipe and auxiliary reservoir, and the hand brake set. If the brake pipe and auxiliary reservoir were charged, and the hand brakes were set, a leak in the brake pipe will cause the air brake to apply with so much greater force than the hand brake, that it may release the pawl or "dog" from the ratchet on the brake rod. When the air has leaked from the brake cylinder the car is without an applied brake. If the hand brakes are defective, the wheels must be blocked and the station agent notified.

FLYING SWITCHES.

The angle cocks of cars to be placed on a siding should always be left open and the auxiliary drained before making a flying switch, thus releasing all air from the car. This will prevent the brakes from applying automatically before the switch has been completed.

TURNING ANGLE COCKS.

The angle cock on the rear of the cars that are charged with air should always be opened gradually when coupling to cars not charged, in order that the reduction in brake pipe pressure will not cause a quick action application of the brakes on the charged cars.

DETACHING ENGINE OR CHANGING MAKE-UP OF TRAIN.

When picking up cars the air should be cut in on the siding for the purpose of having them fully charged before coupling onto the train, after which a terminal test should be made on the cars picked up, as well as seeing that the head and rear air cars set and release. When cars are set out, crossings cut or the engine detached for any purpose, a brake test should be made when recoupled to the train.

UNNECESSARY OPENING OF BLEED COCKS.

The practice of passing along a train and opening the bleed cocks of the auxiliary reservoirs is not a good one, for in many cases the opening of a bleed cock will cause an unnecessary leak. This leak will reduce the pressure in the auxiliary reservoir below that in the brake pipe and release the brake, thus depriving the train of the braking power of this car.

ADJUSTING PISTON TRAVEL.

If the piston travel is too long or too short, it should be adjusted. Caution should be used to prevent accidents or personal injury when adjusting brakes or making repairs to the brake rigging. The cut-out cock

in the cross-over pipe should first be closed, and the air released from the auxiliary reservoir by means of the bleed cock. This will prevent the brakes from applying in the emergency in case a brake pipe or hose should burst in other parts of the train.

The piston travel in the brake cylinder should be from six to eight inches. Less than six inches will cause the brake to apply with such force that on an empty car or a bad rail the wheels are liable to slide. A piston travel of more than eight inches will decrease the braking power.

USE OF HAND BRAKES.

The hand brakes should be used on a train that is composed of part air brake cars and part non-air brake cars when backing in or out of sidings and when backing down descending grades, and should be used on an air brake train whenever called for by the engineman and when leaving cars on a siding.

Hand Brakes on Passenger Trains. Conductors and trainmen on passenger trains should immediately open the conductor's valve whenever the engineman signals for brakes. If no air escapes from the valve it indicates that the air equipment it out of service and they should then immediately set the hand brakes.

TRAIN PIPE OBSTRUCTIONS.

If an angle cock is only partly open, or if there is an obstruction in the brake pipe, an emergency application of the brakes cannot be made on any car behind the obstruction or partly closed angle cock. The quick action triple valve can be operated in the emergency only by making a sudden reduction of brake

pipe pressure. One of the most important duties of trainmen is to see that angle and cut-out cocks are given their full opening.

MAKING UP TRAINS.

A train may be made up in such a manner that the engineman cannot produce an emergency application of the air brakes by the use of the engineman's brake valve, by placing four or more cars that are cut out together, four or more piped cars, or two dead locomotives together (a piped car is one that has a brake pipe with hose connections and angle cocks, but is not equipped with air brake attachments) prevents an emergency application, for the reason that it is impossible to make a sudden reduction of pressure at the triple valve on the car immediately behind the piped cars, the latter retarding the flow of air by frictional resistance through the brake pipe. Not more than three piped or cut-out cars should be coupled together, but should be spaced among other air brake cars or switched to the rear of the train.

BROKEN GRADUATING SPRING.

If there are more than seven cars in a train the breaking of the graduating stem or spring will have no appreciable effect upon the brakes. This is due to the fact that on a train of more than seven cars the reduction in the brake pipe pressure will take place slowly allowing the piston to travel slowly from the release to the service position. As soon as port z reaches a point opposite to port r, the air will immediately commence to flow from the auxiliary into the

brake cylinder, reducing the pressure in the auxiliary reservoir until it equalizes with the pressure in the brake pipe.

BROKEN GRADUATING PIN.

A broken graduating valve pin, that part which connects the graduating valve to the piston stem, will often cause an emergency application of the brakes with a service reduction in brake pipe pressure. Other defects that will produce the same results are broken graduating springs, with seven cars or less, a sticky piston valve, or a bad brake pipe leak when a heavy reduction in brake pipe pressure is made.

AUXILIARY RESERVOIR.

The auxiliary reservoir is a place of storage from which the supply of compressed air is taken to apply the brakes on that particular car through suitable ports in the triple valve, and to the brake cylinder by reducing the pressure in the brake pipe, which causes the triple valve to assume service position.

Effects of Auxiliary Leaks. Leaks in the auxiliary reservoir have no effect other than to release the brakes and increase the labor of the air pump, as the feed grooves are not large enough to cause an appreciable reduction in the brake pipe pressure with the pump in good working condition. Any leakage from the auxiliary reservoir will cause the brakes to release by the pressure in the auxiliary becoming less than that contained in the brake pipe, which would force the piston and slide valve to release position.

Danger in Auxiliary or Cylinder Leaks. Auxiliary or cylinder leaks are more dangerous than brake pipe leaks, for the reason that they will release the brakes after being applied. The loss of braking power creates an element of danger and increases the possibilities of an accident. They will also cause the brakes to apply with greater force on the balance of the train when a given reduction in brake pipe pressure is made by means of the brake valve. The pressure in the brake pipe will flow through feed grooves in the triple valve and results in a constant loss of air pressure from the leak in the auxiliary. The effect of this continuous loss of pressure from the brake pipe will cause the brakes on all other cars to apply with greater force, as it has practically the same effect as a leak in the brake pipe.

UNSEATED RUBBER SEATED VALVES.

If a buzzing or humming sound is heard at the triple valve, it indicates that the rubber seated valve has become unseated or defective. This trouble may sometimes be remedied by striking the body of the triple valve a quick, sharp blow with a piece of wood, or by cutting out the air from the triple valve by means of the cut-out cock in the cross-over pipe, draining the auxiliary of all air and then quickly opening the cut-out cock. The sudden inrush of air often blows out the obstruction which may have become wedged between the emergency valve and its seat.

WHEELS SLIDING.

Wheels generally slide at low and not at high speeds, as the friction between the wheel and brake

shoe increases as the speed of the wheel decreases.

The wheels on a passenger car are more liable to slide than those of a freight car, as a passenger car has a braking power with an emergency application of 90 per cent. of the light weight, while the braking power of empty freight cars is only 70 per cent. of the light weight.

During cold weather trainmen should always examine wheels before starting out, to see that no brake shoes are frozen to the wheels, which can be detected by watching the wheels to see that they revolve when the train is starting from the terminal or when standing for a period of time between terminals.

LEAKAGE GROOVES.

The purpose of the leakage grooves in the brake cylinder is to provide for leakages or slight reductions in brake pipe pressure which would cause the triple valve to move to service position, closing the triple exhaust. Any small volume of air that passes from the auxiliary reservoir to the brake cylinder can pass through the leakage grooves without forcing the piston out, and applying the brakes. Leakage grooves are from 2 1-2 to 3 1-2 inches long and are usually placed on the side or top of the brake cylinder, on the pressure end, or where the piston lies when the brake is released.

REDUCTIONS AND APPLICATIONS.

Many persons do not distinguish the difference between a reduction and an application. An application consists of any number of reductions without releas-

ing the brakes, and may be made several times during an application.

Amount of Reduction. When making a service reduction with any given pressure the proportion it should be reduced to secure a full application of the brakes would, with a standard piston travel of 8 inches, be about two-sevenths of the brake pipe pressure, as the auxiliary reservoir is usually about 2 1-2 times larger than the brake cylinder.

A 10-pound reduction from a brake pipe pressure of 65 pounds will not apply the brake with greater force than a 10-pound reduction from a 50-pound brake pipe pressure, as there is a pressure of only 10 pounds going to the brake cylinder, and it is above the equalization point for the two pressures.

If a reduction of 20 pounds in brake pipe pressure is made with an 8-inch piston travel and a 70 pound brake pipe pressure, the auxiliary reservoir, brake cylinder and brake pipe pressure will equalize at about 50 pounds.

A greater pressure can be obtained in the brake cylinder by carrying a higher brake pipe pressure, shortening the piston travel, or making an emergency application with the quick action triple valve, and by the use of the retaining valves in a second application with both service and emergency applications.

Over-Reduction. An over-reduction is one in which the brake pipe pressure is reduced below the point at which the auxiliary reservoir and brake cylinders equalize. It results in a useless waste of brake pipe air and an irregular and often a difficult release of the brakes. Also, if there is a defective packing ring and gasket in the triple valve on which the triple

piston is seated, air can feed from the auxiliary reservoir to the brake pipe, and decrease the braking power of the car having the defective packing ring.

Number of Applications. One application of the brakes is all that is necessary to stop any train, but it is advisable on passenger trains to make two applications in order to insure smooth and accurate stops, without danger of wheel sliding. More than one application is not advisable on freight trains on account of the uneven piston travel. On a long freight train with the old style triple valve, the head brakes will release before the rear brakes, allowing the slack to run out, with consequent danger of breaking in two. More than two applications should not be made in any case, as sufficient time would not be given between applications for the auxiliary reservoirs to recharge, thus decreasing the braking power.

Service Applications With High Speed Pressure. With full high speed brake pipe pressure, three full service applications may be made without recharging the auxiliary reservoir, and there would still remain as much pressure in the auxiliary as is used with the ordinary brake.

Emergency Applications. An emergency application should be made only in cases of actual emergency to prevent an accident. In making an emergency application the handle of the brake valve should be placed in full emergency position, or an angle cock opened, as quickly as possible, and left there. It is possible to get emergency action of the brakes without losing all brake pipe air, but it is not good practice to attempt to save air at times of pressing danger, and is not advocated under any circumstances. If it

is practiced when several cars which are cut out are placed together, only the brakes ahead of these cars will go into emergency application, while those behind them will apply with only partial service action. If the brake valve is left in full emergency position a full service application will be had on all cars back of the cut-out cars, obstructed hose or partly closed angle cock, in addition to full emergency application on all cars ahead of them. The greatest possibility of danger that an engineman may thoughtlessly bring the brake valve past lap position too far, placing it in running position and thus releasing the brakes. Also if the brake valve were moved to lap position too quickly the sudden stoppage of air in the head end of the brake pipe would release the head brakes, which might also result in parting the train.

RELEASING BRAKES.

To release the brakes it is necessary to increase the brake pipe pressure the entire length of the train above the pressure in the auxiliary, a sufficient amount to overcome the frictional resistance of the triple piston and slide valve.

The length of time required for releasing depends entirely on the length of the train, the amount of the reduction and the size of the main reservoir. Ordinarily one-half second for each car is sufficient for the release of all brakes. On short trains equalization of pressures takes place very rapidly. On long trains equalization takes place slowly, the rear end of the train receiving its increase of pressure more gradually, due partly to frictional resistance in the brake pipe.

Sufficient Time for Releasing. Sufficient time should be given for all brakes to release. On trains of over 30 cars, the head brakes, being nearest the engine, charge more rapidly than the rear ones, due to the pressure being greater in the head end of the brake pipe than in the rear end.

During the time that the pressure is reaching the rear end of the brake pipe on long trains, and the brake valve has been returned to running position, the brake pipe air equalizes from the head to the rear end, causing the head brakes to reapply, which makes it necessary to again place the brake valve in release position for a few seconds, which will release the light application of the head brakes. A double release is thus required on long trains to insure a full release of all brakes.

Failure of Brakes to Release. If the brakes fail to release on a car at the rear of a long train, the trouble is usually due to a worn or defective triple piston packing ring. When the engineman places the brake valve in full release position the pressure in the main reservoir flows through the large opening in the brake valve to the brake pipe, and as it fills the brake pipe the increased pressure strikes each triple piston and forces it to release position, allowing the pressure in the brake pipe to enter and charge the auxiliary through the feed grooves. When the increased pressure in the brake pipe reaches the car with the defective packing ring, it is not enough greater than the pressure in the auxiliary to cause the triple piston to move to release position, but instead the air feeds past the worn packing ring and charges the auxiliary reser-

voir, the triple piston remaining in set position and failing thereby to release the brakes.

When a light reduction is made in the brake pipe pressure on a long train, the pressure from the auxiliary leaks past the defective packing ring as fast as the train pipe pressure is escaping to the atmosphere through the engineman's brake valve without causing the triple piston to move from release to service position, thus failing to apply the brake.

Releasing Before Uncoupling. The air brakes should be released before uncoupling, which prevents the brake shoes from freezinz to the wheels and the triples from freezing in set position in cold weather. If the brakes are left applied when the engine is detached there will be an additional reduction from the brake pipe by leakage, which would require a larger volume of air to release the brakes when the engine was recoupled; also if the brakes released on a grade, the slack would run in, which might start the train. The air brakes should not be relied upon for holding a train on grades when the engine is cut off—hand brakes should always be used.

Brakes Leaking Off. If the brake releases and there is no sound at the triple exhaust there is a leak in the pipe connection leading from the triple valve to the brake cylinder, a leak past the leather gasket in the brake cylinder, or a defect in the brake cylinder or head. If the car is equipped with the high speed reducing valve, it may be due to a defective valve, or a leak in the pipe connection leading to it.

The leaks enumerated can be detected by making a service application of the brakes and examining all

pipe connections and joints with a torch while the brakes are applied.

Distinguishing Leaks. To distinguish between a leaky body gasket or a leaky auxiliary tube on freight equipment from a leaky slide valve, apply the brakes, and if the leak is in the gasket or tube the blow will cease, while with a leaky slide valve the blow will continue.

Check Valve Leaks. If a check valve leaks, it will have no effect when a full service application of the brakes is made, but will allow the brake cylinder pressure to leak back into the brake pipe, if an emergency application of the brakes is made, or the brake pipe pressure reduced below that in the brake cylinder by an over-reduction in brake pipe pressure.

AUTOMATIC APPLICATION.

If the brake suddenly applies without a reduction being made by the engineman, it may be caused by a burst hose, the train parting or the conductor's valve being opened.

If the train has parted and the sections come to a stop, or in case of a burst hose, the brake valve should be kept moving from running to lap position until the defective hose or leak is located by the trainmen from the intermittent sound of the escaping air. When the defect has been located and the angle cock closed just ahead of it, the brakes should then be released, the brake valve placed in lap position and excess pressure obtained in the main reservoir, so that the brakes on the rear cars may be released when the

defective hose has been replaced or the train has been recoupled.

USE OF TAIL HOSE.

When backing up a train with the tail hose in use, the brake pipe should first be blown out before attaching the hose, the terminal or road test of the air brakes should be made by the engineman and a test of the tail hose should then be made by the trainmen stationed on the rear car. The latter test should be made after the train is in motion, the first application being made about 200 feet or three car lengths from the starting point. If a slow-down is not felt within this distance the engineman should bring the train to a stop and ascertain why the test has not been made. Following either a slow-down or a stop, when a signal to continue backing is given, the brake valve should be moved to release position, as in making a regular brake release, to insure a release of all brakes. The engineman should apply the automatic brakes whenever it is required to insure the safety of the train, in the absence of a sufficient application from the tail hose.

Trainmen should understand that in operating the brakes with the tail hose, the valve of the tail hose should be opened slowly and the opening gradually increased until the valve is wide open, or the train has slowed down as much as desired or has been brought to a stop. This valve should not be opened and closed. If the application has been too hard the closing of the valve will allow the brakes to release and recharge. The rapidity with which the valve is opened should be determined by the speed, the length

of the train and the distance within which it must be stopped. In cases of emergency the valve should be instantly opened to its full extent.

TWO OR MORE ENGINES COUPLED.

When two or more engines are coupled together the engineman on the leading engine should do the braking, as his view is not obstructed, and he is able to exercise the better judgment in handling the brakes.

THE WESTINGHOUSE QUICK ACTION TRIPLE VALVE.

The quick action valve receives its name from three distinct operations it performs in response to variations of brake pipe and auxiliary reservoir pressures, which are (1) it charges the auxiliary reservoir; (2) applies the brakes; (3) releases the brakes. The various positions of the working parts of the triple in accomplishing these results are shown in Figs. 1, 2, 3 and 4. Fig. 5 is a perspective view of the slide-valve and its seat.

List of Parts. The various parts of the triple valve, as shown in Fig. 1, are as follows:

2. Triple Valve Body.
3. Slide Valve.
4. Main Piston.
5. Piston Packing Ring.
6. Slide Valve Spring.
7. Graduating Valve.
8. Emergency Piston.
9. Emergency Valve Seat.
10. Emergency Valve.
11. Emergency Valve Rubber Seat.
12. Check Valve Spring.
13. Check-Valve Case.
14. Check-Valve Case Gasket.
15. Check Valve.
16. Strainer.
19. Cylinder Cap.
20. Graduating Stem Nut.
21. Graduating Stem.
22. Graduating Springs.
23. Cylinder Cap Gasket.
28. Emergency Valve Nut.

i and k. Feed Grooves.

Strainer 16 is designed to exclude foreign matter from the triple valve. Piston 4 operates in response to variations of brake pipe and auxiliary reservoir

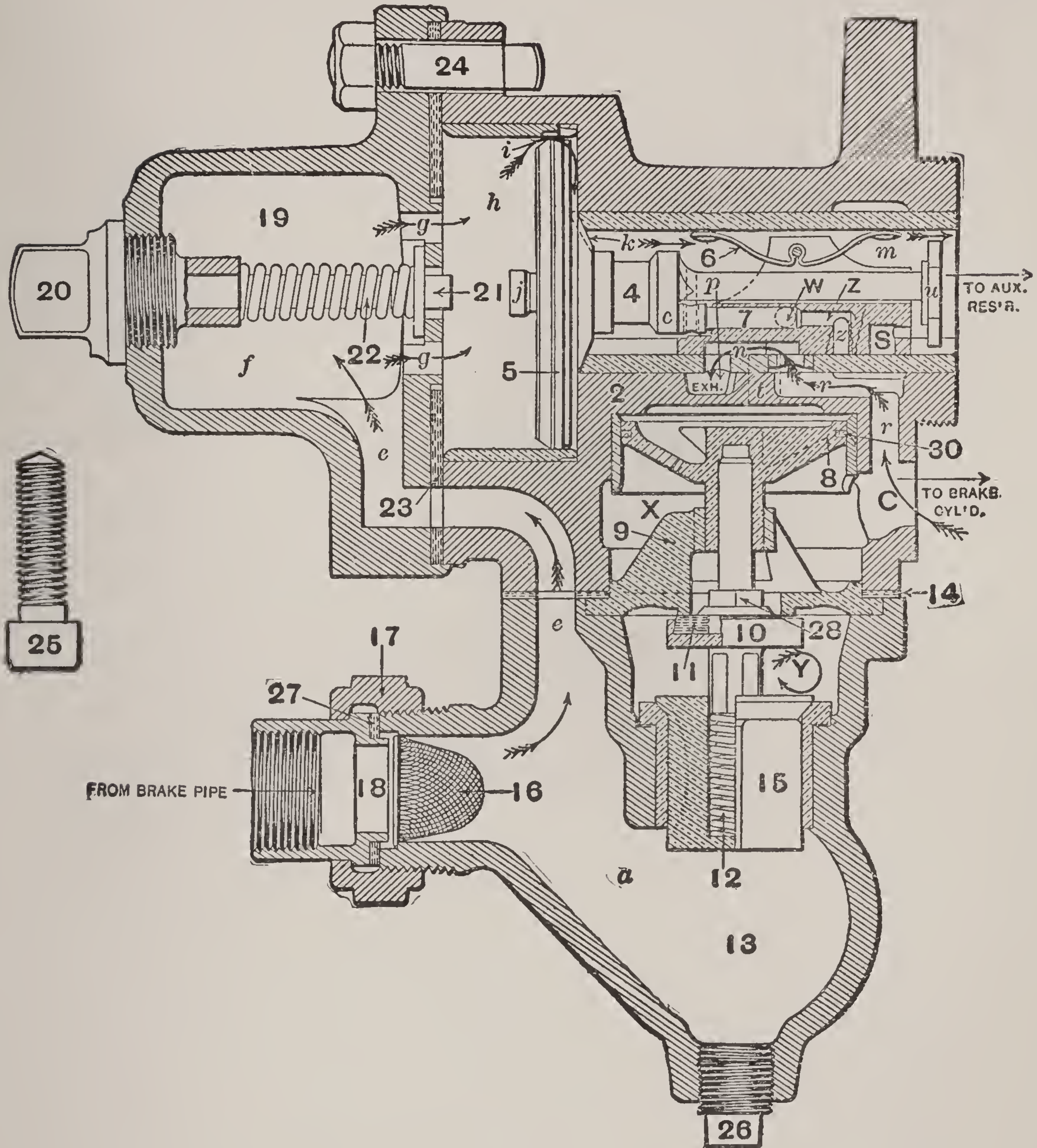


Fig. 1.

Release and Charging Piston.

pressures, to open and close feed groove i, and controls the movement of the slide valve and graduating valve. The latter is secured to the piston stem by a pin, shown by dotted lines.

The graduating valve (in a service application), moved by a main piston, controls the flow of air from the auxiliary reservoir through ports W and Z of the slide-valve.

The slide-valve, moved by the main piston, controls communication between the brake cylinder and the atmosphere, between the auxiliary reservoir and the brake cylinder, and also between the auxiliary and the chamber above emergency piston 8.

Charging. Air from the brake pipe enters the triple valve at a (Fig. 1) and flows through passages e, f, g and h, past the main piston, through feed grooves i in the bushing and k in the piston seat, and thence through chamber m to the auxiliary reservoir, as indicated. Air continues to flow from the brake pipe to the auxiliary reservoir until the pressures equalize, when the main piston is balanced.

The main piston constitutes a movable partition wall, separating the brake pipe and auxiliary reservoir pressures, and in studying the operation of the triple valve under various conditions the first essential consideration is always as to which face the main piston is exposed to the greatest pressure, as this determines the direction in which it will move. The usual brake pipe pressure is seventy pounds, acting upon both faces of the main piston when the brake pipe and auxiliary reservoirs are fully charged.

Service Application. To apply the brakes for a service stop, a gradual reduction of brake pipe pres-

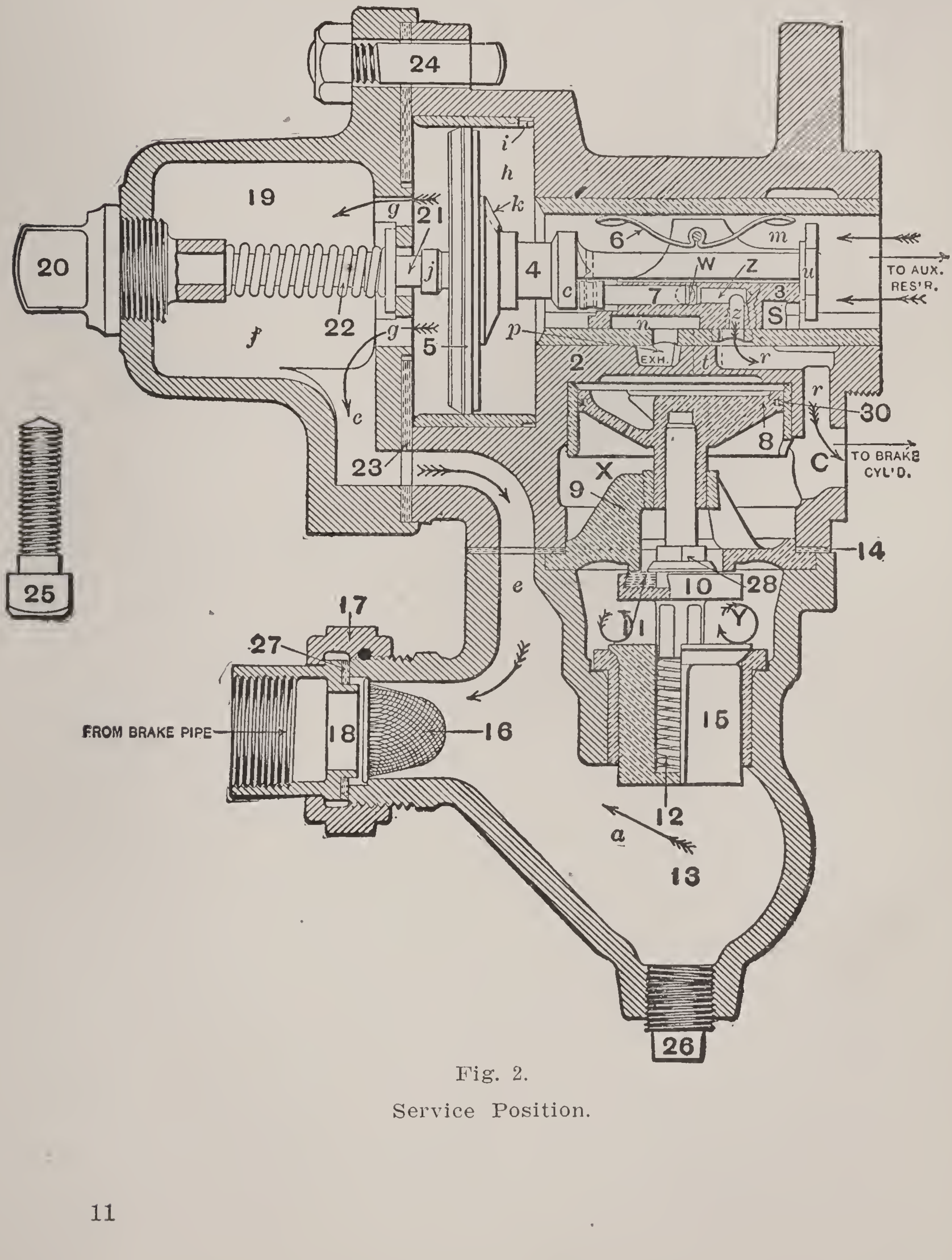


Fig. 2.

Service Position.

sure is required, and for the purpose of illustration the first reduction will be one of five pounds, thus leaving a pressure of sixty-five pounds to act upon the brake pipe face of the main piston, while the original seventy pounds still operate upon the auxiliary reservoir face. As a result of this reduction, the greater auxiliary reservoir pressure forces the main piston to the left. As the piston moves it closes feed groove i, cutting off communication between the brake pipe and the auxiliary reservoir, and unseats graduating valve 7, establishing communication between transverse passage W and port Z of the slide-valve. When the graduating valve has become unseated, the collar at the end of the piston steam engages the slide-valve, which is then also moved to the left by the further movement of the piston, thereby cutting off communication between exhaust cavity n in the slide-valve and passage r leading to the brake cylinder. The movement of the main piston to the left is arrested by contact of its stem j with graduating stem 21, which is held in position by graduating spring 22. In this position port Z in the slide-valve registers with port r, and auxiliary reservoir air flows through ports W and Z of the slide-valve and passage r to the brake cylinder at C (Fig. 2). When the auxiliary reservoir pressure has become slightly less than that (sixty-five pounds) upon the brake pipe face of the main piston, the greater brake pipe pressure forces the piston back sufficiently to seat the graduating valve as shown in Fig. 3. This is known as "lap" position.

If it is afterwards desired to apply the brakes with greater force, a further brake pipe reduction is made which again leaves the auxiliary reservoir pressure

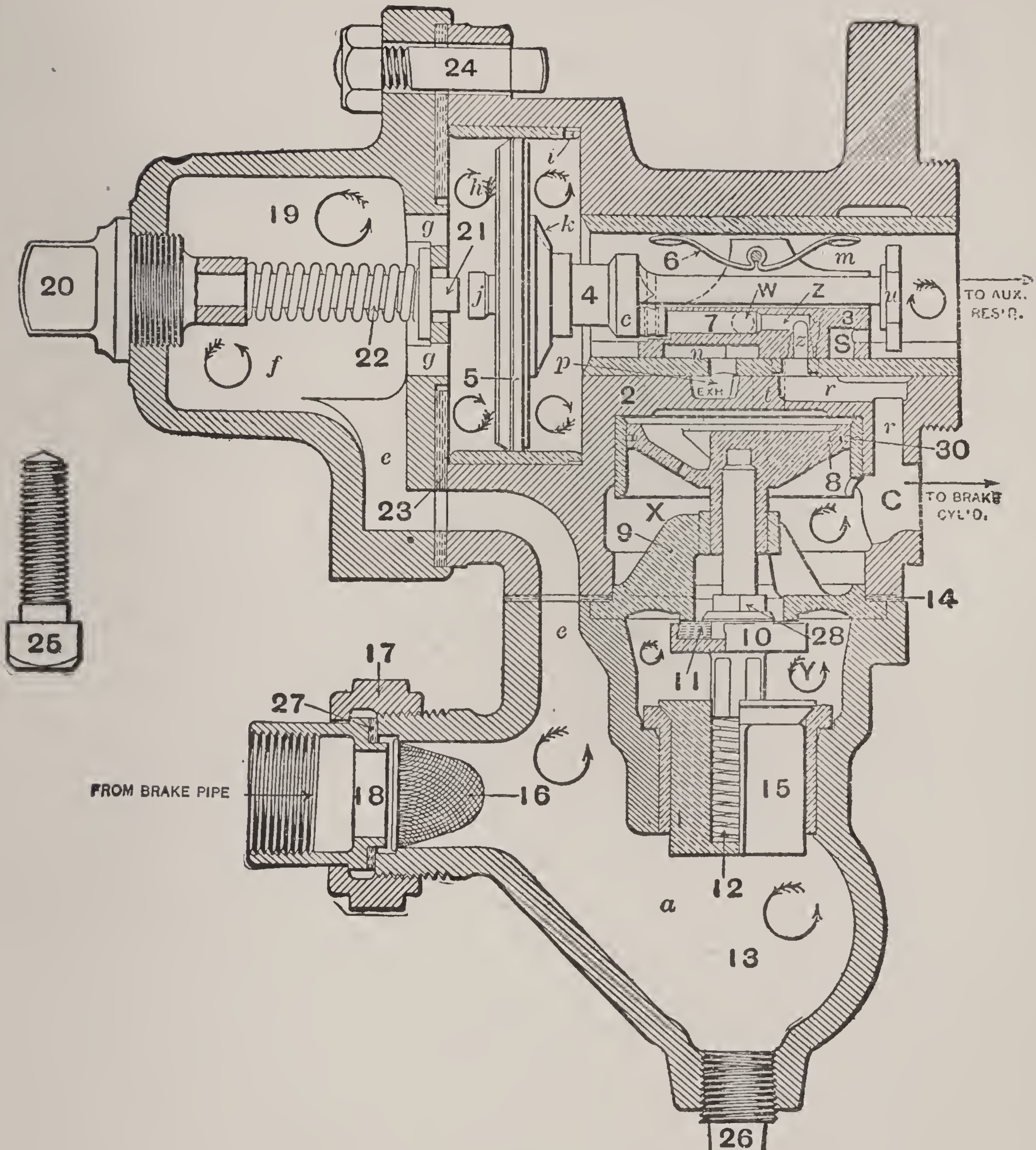


Fig. 3.

Lap Position.

in excess of that in the brake pipe, which will force the main piston to the left and unseat graduating valve 7. A corresponding further reduction of auxiliary reservoir pressure results, through the discharge of air into the brake cylinder. Such brake pipe reductions may be repeated until the auxiliary reservoir and brake cylinder pressures are equal. The brakes are then fully applied and any further brake pipe reduction is a waste of air. A total reduction of about twenty pounds causes the brake pipe, auxiliary reservoir, and brake cylinder pressures to equalize.

Emergency Application. A gradual or service reduction of brake pipe pressure causes the main piston to move to the left until stem *j* encounters stem 21, when the tension of the graduating spring prevents a further movement, but a sudden brake pipe reduction causes the main piston to move out so quickly that graduating spring 22 cannot withstand the impact of stem *j*, but yields so that the piston moves to the position shown in Fig. 4. In this position a diagonal slot in the slide-valve (Fig. 5) uncovers port *t* (indicated by dotted lines just below the letter Z), which admits air from the slide-valve chamber to the chamber above emergency piston 8. Piston 8 is thereby forced downward and unseats emergency valve 10, allowing the pressure in the small chamber Y, above check-valve 15, to escape into the brake cylinder. The brake pipe pressure almost instantly raises the check-valve, and the brake pipe air rushes through chambers *a* and Y into the brake cylinder at C. Air from the auxiliary reservoir simultaneously flows through port S of the slide-valve and passage *r* into the brake cylinder, but port S being very small in comparison with the passage-way through chambers *a,* Y and C, only a small amount

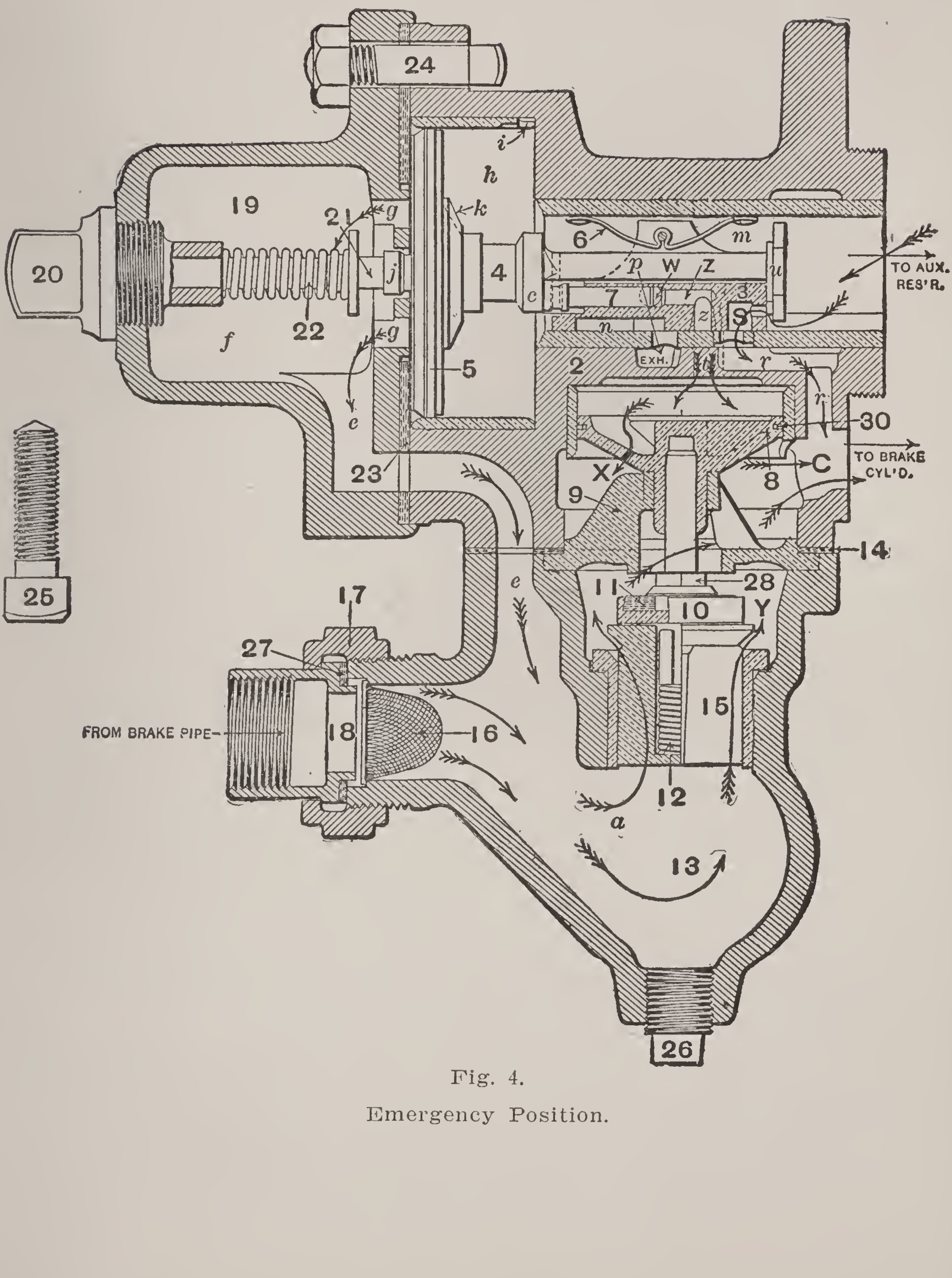


Fig. 4.

Emergency Position.

of auxiliary reservoir air reaches the brake cylinder before the brake pipe and cylinder pressures are equalized, allowing the check-valve to seat, preventing the air from escaping fro mthe cylinder to the brake pipe. It thus may be seen that in an emergency application an increased brake cylinder pressure is secured through the presence of the air supplied by the brake pipe, in addition to that from the auxiliary reservoir, which is the only source of air pressure for the brake cylinder during a service application of the brakes.

The rapid discharge of air from the brake pipe into the brake cylinder, in addition to the sudden reduction made at the brake-valve, causes a similar operation of the triple valve upon the next car. The operation of that triple valve similarly affects the next, and so on serially throughout the train.

Release. To release the brakes, the engineman admits main reservoir pressure into the brake pipe, thus increasing the pressure upon the brake pipe face of the main piston until it becomes greater than that upon the auxiliary reservoir side, and forcing the piston to its normal or release position, shown in Fig 1. In this position the air in the brake cylinder is discharged through passage *r*, exhaust cavity *n* in the slide-valve, and passage *p* to the atmosphere, either directly or through the pressure retaining valve. Feed groove *i* being again uncovered, the auxiliary reservoir becomes recharged with air from the brake pipe.

Purposes of the Triple Piston, Slide and Graduating Valves. The duty of the triple piston is to open and close the feed groove and to guide the movement of the slide-valve and graduating valve, and also to form a

dividing line between the auxiliary reservoir and brake pipe pressures.

The purpose of the slide-valve is to open and close communication between the brake cylinder and the atmosphere and to open and close communication between the auxiliary reservoir and the brake cylinder in conjunction with the graduating valve and the triple piston. It is also the duty of the slide-valve in the quick

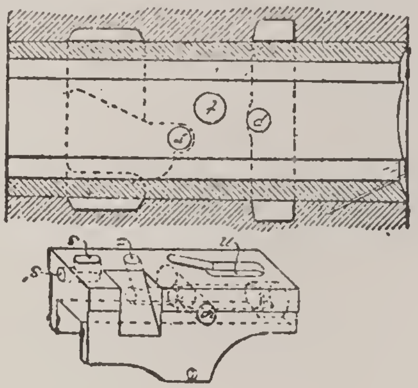


Fig. 5.

Slide Valve and Seat.

acting triple to open and close communication between the auxiliary reservoir and the emergency piston, and between the auxiliary reservoir and the brake cylinder in conjunction with the triple piston.

The duty of the graduating valve is to graduate the flow of air from the auxiliary reservoir to the brake cylinder.

DEFECTS OF THE WESTINGHOUSE QUICK ACTION TRIPLE VALVE.

Defects that will cause a blow at the triple exhaust are, the slide valve held off its seat by dirt, the slide valve seat cut, a defective gasket 15 between the auxiliary and

the triple valve, defective gasket between the brake cylinder head and the triple valve, auxiliary tube b in freight equipment becoming cracked, defective check case gasket 14, or a defective rubber seated valve 10.

A slide valve leak, defective gasket between the triple and auxiliary, cracked auxiliary tube *b,* or leaky gasket between the triple and brake cylinder would have the effect of reducing the pressure in the auxiliary reservoir and releasing the brake, while a leaky gasket 14 or a leak in the rubber seated valve 10 would reduce the brake pipe pressure and tend to set the brake with greater force.

How to Distinguish Leaks. To distinguish between the various blows at the triple exhaust, a ten-pound reduction should be made. If the blow stops, the brake sets harder, then releases, and the blow starts again at the triple exhaust, the trouble is due to a leak between the triple and auxiliary or between the triple and brake cylinder, or a cracked auxiliary tube *b.* But if, after making the reduction, the blow continues and the brake releases, it would be due to a defective slide valve, while if the blow stopped at the triple exhaust, the brake set harder and did not release, it would indicate a leak at gasket 14 or at the rubber seated valve.

A leaky bleed cock, a leak in the pipe connection leading from the triple valve to the auxiliary reservoir or the pipe connection leading from the triple to the brake cylinder, the packing leather in the brake cylinder becoming worn, the piston not covering the leakage grooves, or a leak between the brake cylinder head and the cylinder will also release the brake.

The effect produced by a leak at the graduating valve is uncertain and would depend on the conditions connected with it. When the brake is applied the

triple valve assumes lap position. If the graduating valve leaks, the auxiliary pressure gradually reduces and the brake pipe pressure forces the piston and slide-valve back until the blank on the face of the slide-valve between ports z and u is in front of port r. This blank space is only a trifle wider than port r. If the valve is in good condition and works smoothly, the brake should not release, but if it works hard it is likely to jump when it moves, thus opening the exhaust port and releasing the brake.

NEW TYPES OF WESTINGHOUSE TRIPLE VALVES.

The greatly changed conditions in the operation of railway trains during the past few years, incident to the employment of locomotives capable of handling long trains of freight cars, as well as the large number of air brakes in such trains, also the air brake requirements in connection with passenger trains, have created conditions which the well known types of triple valves have in many instances proved unable to meet.

By reference to cuts showing the arrangement of the ports in the slide-valve, graduating valve and slide-valve bushing of this new type of triple (Fig. 7) it will be noted that the general arrangement of the ports is along each side of the longitudinal center line, rendering it somewhat difficult to follow the course of air through them with sectional views in which the actual arrangement of ports is shown. Diagrammatic cuts are used, therefore, for illustrating the valves in their several positions, all ports and passages having been so rearranged as to place them on a single plane. In preparing these cuts the actual proportion and mechanical construction of the valves has been sacrificed for the purpose of making them as easily understood as possible.

In this new valve, the triple piston, slide-valve and graduating valve are the same in their relation to each other as in the older well known types of triples, the graduating valve, however, being of the sliding type and located on top of the slide-valve. The triple piston constitutes a movable partition separating brake

pipe and auxiliary reservoir pressure. To apply or release the brake, air pressure is reduced or increased until a sufficient differential is created on opposite sides of the piston to overcome the friction of the piston packing ring and slide-valve.

THE TYPE "K" TRIPLE VALVE.

The new quick action freight triple valve, designated as type "K", facilitates train movements, increases the factor of safety in handling trains, and reduces damage to lading and equipment in so far as they are affected by air brake operation.

Improvement Over the Old Type Triple. The old type "H" quick action freight triple valve was designed to meet the requirements of the time when fifty car trains, thirty ton capacity cars and moderate speed were maximum conditions. But the increased train lengths, higher speed and greater car capacities of the present have demanded certain modifications to meet these, and anticipate future requirements.

The "K" triple embodies every feature of the old type, and in addition three new ones called the Quick Service, Retarded Release and Uniform Recharge. It not only works in harmony with the old valves, but greatly improves the action of the latter when they are mixed in the same train. They have many parts in common, are interchangeable, and the old type quick action triple can be converted into the new, without the loss of many parts.

Quick Service. The quick service feature, which produces a quick serial operation of the brakes in service application, has been obtained by utilizing the

well known principle of quick action in emergency applications, by which each triple valve augments the brake pipe reduction by discharging brake pipe air into its brake cylinder. The essential difference is that in emergency the maximum braking power is always obtained with both the old and new types of valves, while with the new valve, the power of its quick service application is always under complete control and is governed by the reduction made at the brake-valve. The result is that the quick service feature insures the prompt and reliable response of every brake; eliminates the undesirable use of emergency applications where an unforeseen danger or the need of making accurate stops frequently necessitates such applications with the old standard freight brake equipment; reduces the possible loss of air due to its flowing back through the feed grooves from the auxiliary reservoir to the brake pipe, or by the leakage grooves in the cylinders, and gives a more uniform application of the brakes throughout the train.

Release Feature. The retarded release feature, which insures practically a uniform release of all brakes, has been effected by automatically restricting the exhaust of air from the brake cylinders at the head end of the train, and allowing all others to release freely. To obtain this result requires merely the usual correct method of operating the brake valve, the retarded release being due to the quick and considerable rise in brake pipe pressure which occurs in the brake pipe for about twenty-five or thirty cars from the locomotive in long trains. This is possible, for the reason that the frictional resistance to the flow of air through the brake pipe prevents the building

up of brake pipe pressure in the balance of the train faster than it can flow into the auxiliary reservoirs.

Recharging. The uniform recharge of the auxiliary reservoirs throughout the train is obtained by the fact that when the triple valve is in retarded release position the charging ports between the brake pipe and the auxiliary reservoir are automatically restricted. As long as the release of brake cylinder exhaust is retarded, the recharge is restricted, and since the one feature depends upon the other the restricted recharge operates only on the first twenty-five or thirty cars back of the locomotive, the remaining brakes recharging normally, thus insuring practically a simultaneous recharge of all brakes in the train.

This feature not only avoids the overcharge of the auxiliary reservoirs on the front cars and the subsequent undesired reapplication of their brakes, but, by drawing less air from the brake pipe, permits the increase in brake pipe pressure to travel more rapidly to the rear for the purpose of releasing and recharging those brakes.

Sizes of Valves. The new triple valve is at present manufactured in two sizes, the K-1 for use with eight inch freight car brake cylinders, corresponding with the H-1 and the K-2 for use with ten inch freight car brake cylinders, corresponding with the H-2. Each valve is marked with its designation on the side of the valve body, and the K-2 may be distinguished from the K-1 by the fact that it has three, instead of two, bolt holes in the reservoir flange. Also, in order to distinguish the type "K" valves from the old standard type, their exterior being similar when they are attached to the auxiliary reservoir, a lug is cast on the

top of the valve body. This enables any one to distinguish them at once.

List of Parts. Fig. 6 shows a vertical cross section of this valve, and the names of the various parts as follows:

2. Valve Body.
3. Slide-Valve.
4. Piston.
5. Piston Packing Ring.
6. Slide-Valve Spring.
7. Graduating Valve.
8. Emergency Piston.
9. Emergency Valve Seat.
10. Emergency Valve.
11. Emergency Valve Rubber Seat.
12. Check-Valve Spring.
13. Check-Valve Case.
14. Check-Valve Case Gasket.
15. Check-Valve.
16. Air Strainer.
17. Union Nut.
18. Union Swivel.
19. Cylinder Cap.
20. Graduating Stem Nut.
21. Graduating Stem.
22. Graduating Spring.
23. Cylinder Cap Gasket.
24. Bolt and Nut.
25. Triple Valve Cap and Screw.
26. Drain Plug.
27. Union Gasket.
28. Emergency Valve Nut.
29. Retarding Device Bracket.
30. Retarding Device Screw.
31. Retarding Device Stem.
32. Retarding Device Washer.
33. Retarding Device Spring.
34. Retarding Device Stem Pin.
35. Graduating Valve Spring.

Positions of Ports, Passages and Cavities. Fig. 7 shows the relative positions of the ports and cavities in the slide-valve, graduating valve and slide-valve seat. As it is difficult to show all of these in a single

section, diagrammatic cuts of the valve are used, showing it in each of its principal positions, all ports and passages having been so arranged as to place them on one plane. In preparing these cuts the actual proportion and mechanical construction of the valve have been disregarded for the purpose of making the connections of ports and the operation of the valve more easily understood.

Retarding Device. Referring to Fig. 6 the branch from the brake pipe connects at union swivel 18. The retarding device bracket 29 projects into the auxiliary reservoir, and by its construction free communication exists between the auxiliary reservoir and chamber R, in which slide-valve 3 and graduating valve 7 operate. The retarding device stem 31, through its extension into chamber R and the action of its spring 33, forms the stop against which the stem of piston 4 strikes when it moves to release position, from right to left in the cut, it being shown in full release.

Openings. The opening marked "To Brake Cylinder" comes opposite one end of the tube which leads through the auxiliary reservoir to the brake cylinder, when the valve is bolted in place on the end of the auxiliary reservoir. This opening in the triple valve leads to chamber X over the emergency valve to and under emregency piston 8, it also leads through port *r* to the seat under slide-valve 3. The emergency piston 8 and the parts below it are the same as in the older quick action freight triple valve. Port *y* (shown by dotted lines) connects chamber Y, between check-valve 12 and emergency valve 10, with port *y* in the valve-seat (Fig. 6).

(Note.) Dotted lines are used to indicate a port or part which is hidden by other parts of the mechanism,

and would not be seen when looking at the device from the point of view taken. Some examples of this are shown in Fig. 8.

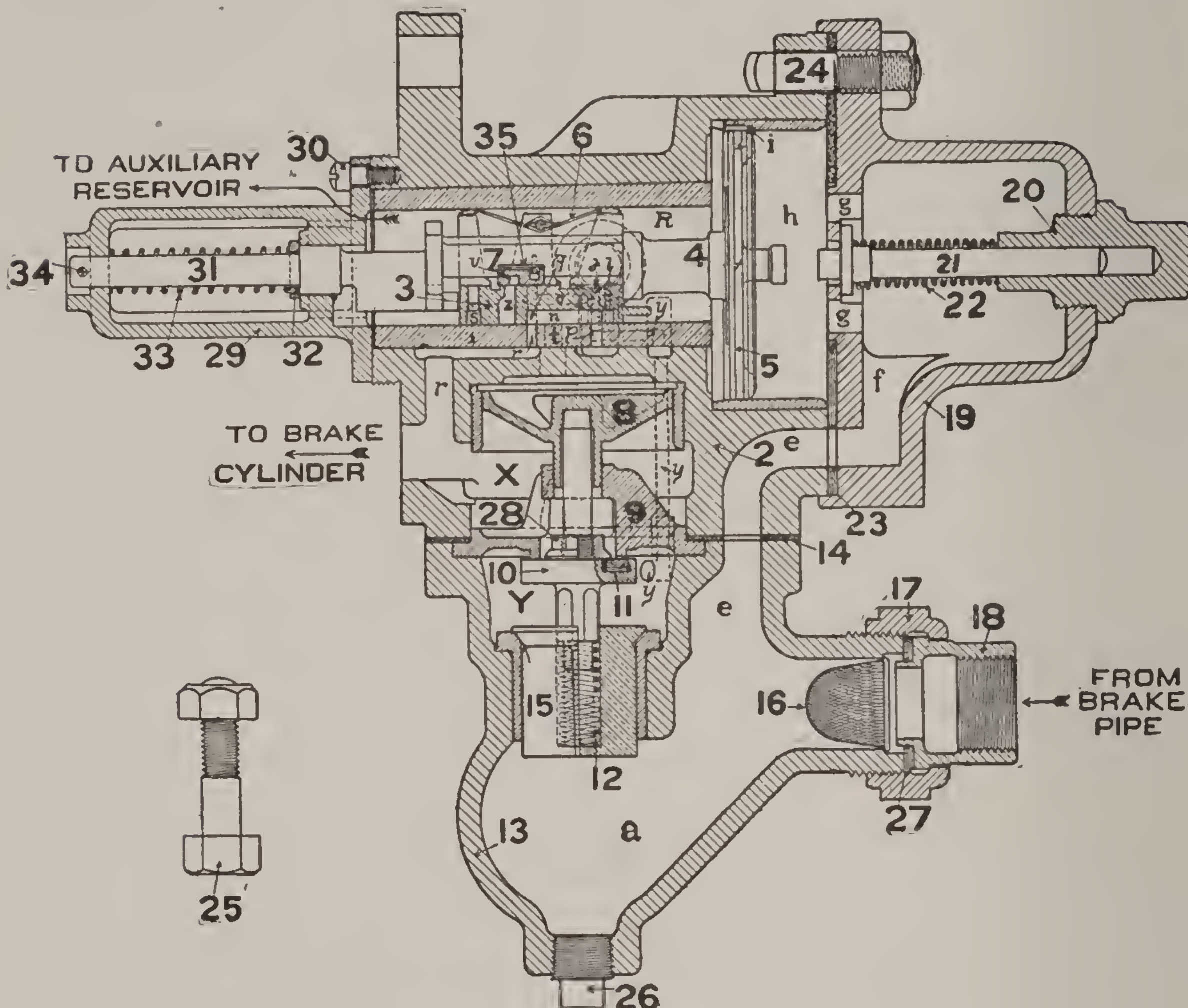


Fig. 6.

Cross Sectional View.

Ports. Port *t* connects the slide-valve seat with the chamber above emergency piston 8.. Port *p* is the exhaust port to the atmosphere. Port *j* in the slide-valve begins at the face as shown by the top view (Fig. 8) and passes around other ports in the valve to a smaller opening in the top. (Port *j* does not exist in the K-1 triple valve, as will be explained later.) Port *o* is similarly arranged, except that the openings in the top

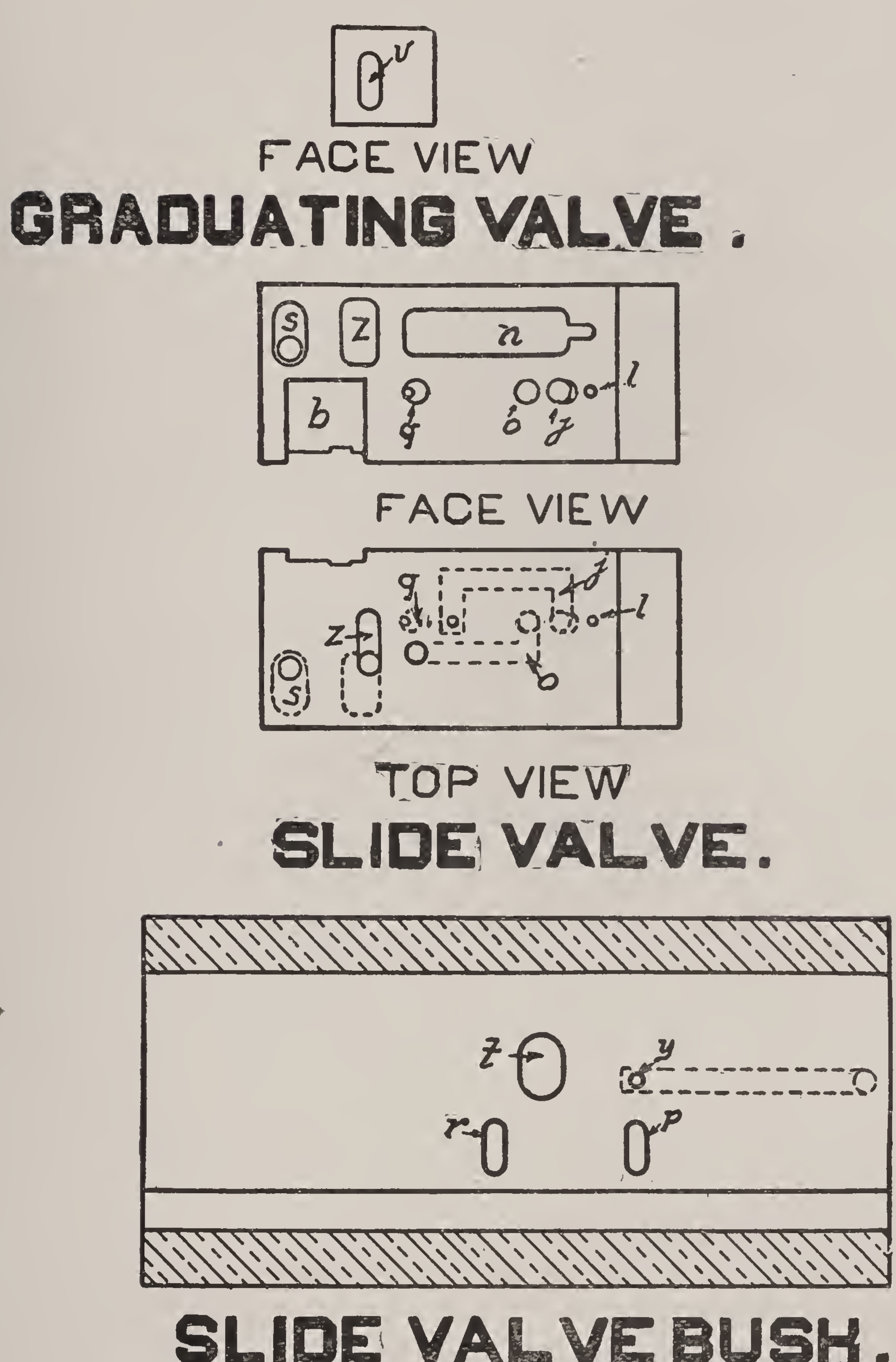

v
FACE VIEW
GRADUATING VALVE.
s
z
n
l
b
q
o
y
FACE VIEW
q
y
l
z
s
TOP VIEW
SLIDE VALVE.
z
y
r
p
SLIDE VALVE BUSH.

Fig. 7.

and bottom are alike in size. Port *q* runs directly through the slide-valve, but is smaller at the top than at the face of the valve, and the smaller part is out of center with the larger part. Ports *s* and *z* run through the

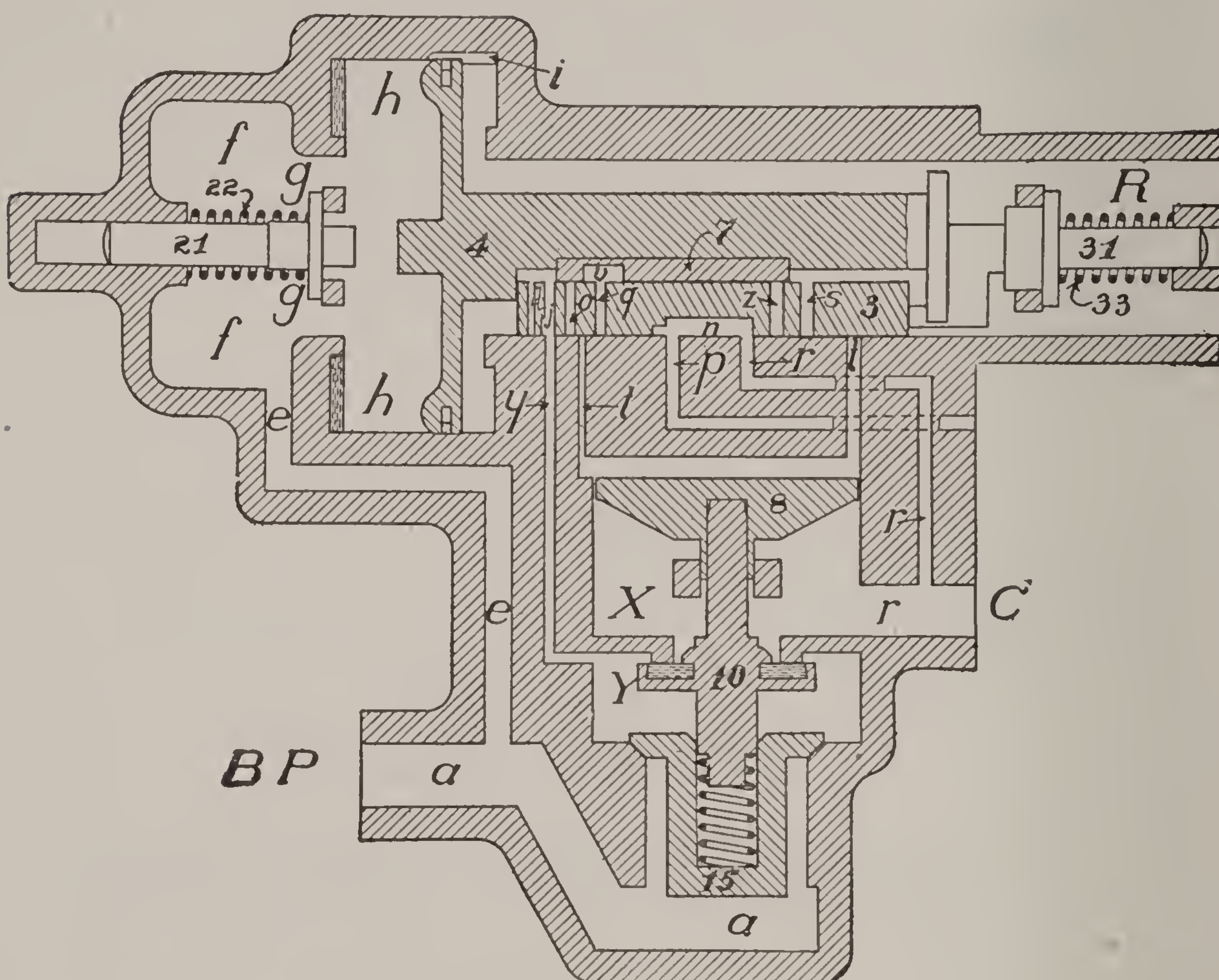


Fig. 8.

Full Release and Charging Position.

valve and connect with cavities in the face; port *z* also has a cavity at the top.

Cavities. The face view of the graduating valve shows that it has a small cavity *v*. This valve is of the slide-valve type, and it seats on top of the slide-valve, where it controls the upper ends of ports *z*, *q*, *o* and *j*. The purpose of cavity *v* is to connect the upper ends of

ports *o* and *q* in a service application, which will be explained in detail later.

As shown by the face view of slide-valve, *n* is a long cavity, having a narrow extension at the right hand end. This cavity connects the ports through which the air escapes from the brake cylinder in releasing. Port *b* is cut diagonally from the face until it just cuts into the edge at the top of the slide-valve. It admits auxiliary reservoir pressure to port *t* in an emergency application.

With this explanation and by occasional reference from the diagrammatic views to those in Fig. 6, the same ports being lettered alike, a clear understanding will be obtained of both the operation and actual arrangement of the ports of the triple valve.

Full Release and Charging Position. Fig. 8 is a diagrammatic view of the triple valve in this position. Air from the brake pipe flows through passage *a* to *c* and cylinder cap *f*, and ports *g* to chamber *h*; thence through feed groove *i*, now open, to chamber R above the slide-valve, which is always in free communication with the auxiliary reservoir. The feed groove is of the same dimension as that of the old standard H-1 triple valve, which is designated to properly charge the auxiliary reservoir of an eight-inch brake cylinder and prevent any appreciable amount of air from feeding back into the brake pipe from the auxiliary reservoir during an application. For this reason the feed groove of the K-2 triple valve is made the same size as the K-1, so that it is necessary in the K-2 triple to increase the charging port area, through which the air can feed into the auxiliary reservoir sufficiently to enable it to handle the greater volume of the auxiliary reservoir of a ten-inch brake cylinder. In order to do this, the small port *j* is added

to the slide-valve of the K-2 triple valve only; this port registers with port *y* in the slide-valve seat when in full release position. Air then passes from chamber Y, through ports *y* and *j* to chamber R and the auxiliary reservoir. Brake pipe air in *a* raises check-valve 15 and supplies chamber Y with air as fast as it is required. Port *j* is so proportioned that the rate of charging the auxiliary reservoir of a ten-inch brake cylinder is made practically the same as that of the eight-inch, which in full release is fed through the feed groove *i* only.

In the following description the K-2 triple valve only is referred to; the operation of the K-1 is exactly the same except for the absence of port *j*.

Air flows from the brake pipe to the auxiliary reservoir until their pressures become equal, when the latter is then fully charged.

Quick Service Application. To make a service application of the brakes air pressure is gradually reduced in the brake pipe and thereby in chamber *h*. As soon as the remaining pressure in the auxiliary reservoir and chamber R becomes enough greater than that in chamber *h* to overcome the friction of the piston 4 and graduating valve 7, these two move to the left until the shoulder on the end of the piston stem strikes against the right-hand end of the slide-valve, when it also is moved to the left until the piston strikes the graduating stem 21, which is held in its place by the compression of the graduating spring 22. The parts of the valve are then in the position shown in Fig. 9. The first movement of the graduating valve closes the feed groove *i*, preventing the air from feeding back into the brake pipe from the auxiliary reservoir, and also opens the upper end of port *z* in the slide-valve, while the movement of the latter closes the

connection between port *r* and the exhaust port *p*, and brings port *z* into partial registration with port *r* in the slide-valve seat. Auxiliary reservoir pressure then flows

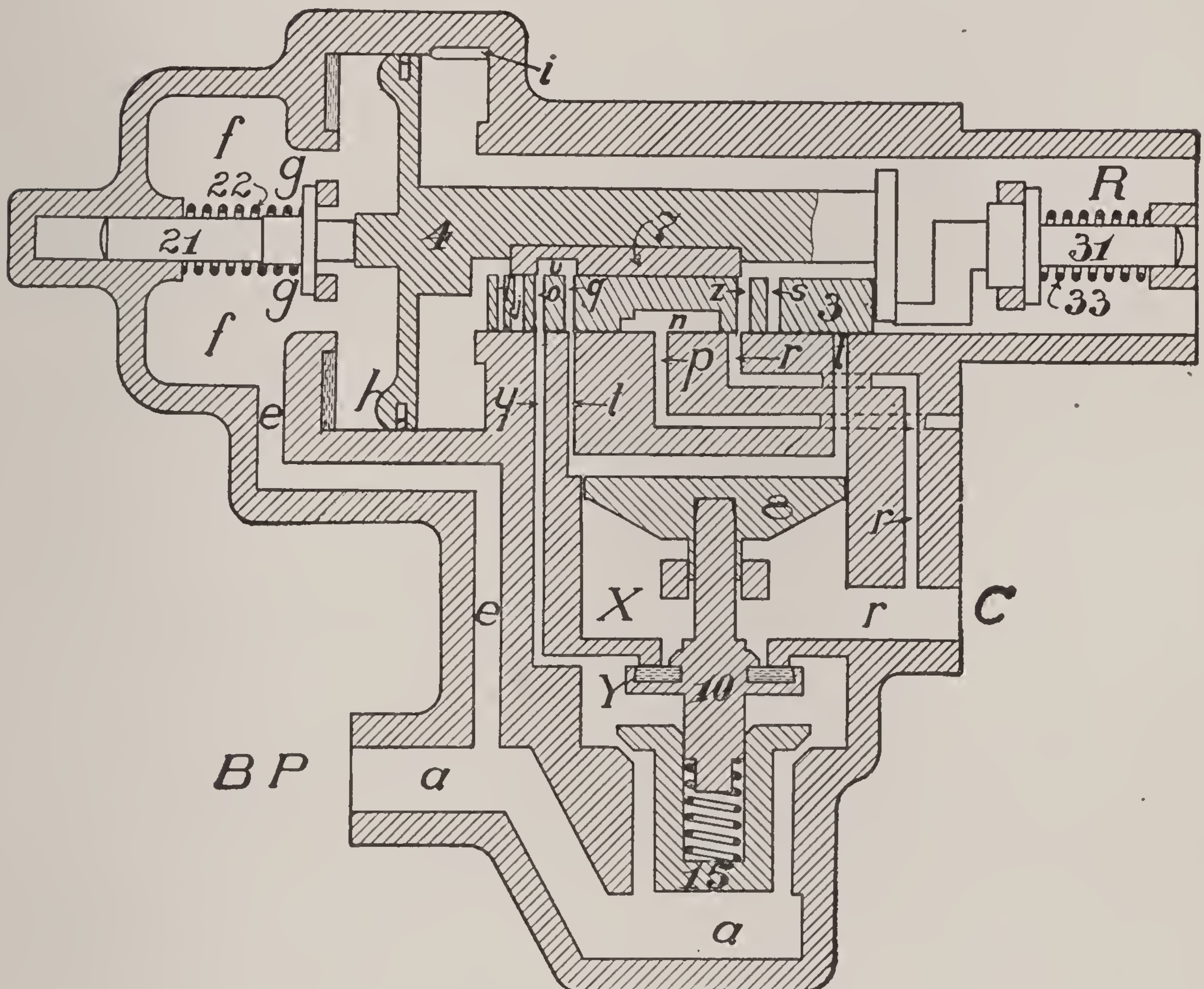


Fig. 9.

Quick Service Position.

through port *z* in the slide-valve and port *r* in the seat to the brake cylinder.

At the same time the first movement of the graduating valve connected the two ports *o* and *q* in the slide-valve by the cavity *v* in the graduating valve, the movement of the slide-valve brought port *o* to register with port *y* in the slide-valve seat and port *q* with port *t*. Con-

sequently, the air pressure in chamber Y flows through ports *y, o, v, q* and *t,* thence around the emergency piston 8, which fits loosely in its cylinder, to chamber X and the brake cylinder. When the pressure in chamber Y has reduced below the brake pipe pressure remaining in *a,* the check-valve raises and allows the brake pipe air to flow by the check-valve and through the ports above mentioned to the brake cylinders. The size of these ports is so proportioned that the flow of air from the brake pipe to the top of emergency piston 8 is not sufficient to force the latter downward and thus cause an emergency application, but at the same time takes considerable air from the brake pipe, thus increasing the rapidity with which the brake pipe reduction travels through the train.

ADVANTAGES OF THE "K" TYPE TRIPLE VALVE IN QUICK SERVICE APPLICATION.

With the old style quick action triple valve in service application, all of the brake pipe reduction is made at the brake-valve, and the resulting drop in pressure passes back through the train at a rate depending on its length, size of brake pipe, number of bends, corners, etc., which cause friction and resistance. A much heavier application of the head than of the rear brakes is also caused at the beginning of the application, thereby running the slack in, which is liable at low speeds to be followed by the slack running out suddenly when the rear brakes do apply, causing a loss of time and difficulty in making quick slow-downs and accurate stops and, with very long trains, results in such serious losses through leakage grooves and feed grooves as to lose a portion of the

braking power and even prevent some brakes from applying. With this new triple valve, only a small part of the reduction is made at the brake-valve, while each triple acts momentarily as a brake-valve to increase the reduction under each car, thereby rendering the resistance and friction in the brake pipe of much less effect and hastening the application throughout the train. This is called the "Quick Service" feature, and by means of it the rapidity of a full service application on a fifty car train is increased about fifty per cent. The rapid reduction of brake pipe pressure moves the main piston 4 quickly to the service position and cuts off any flow back from the auxiliary reservoir through the feed groove to the brake pipe; it rapidly drives the brake cylinder piston beyond the leakage groove and prevents loss of air through it, and yet permits the applying of brakes with as moderate a brake force as desired. It also greatly reduces the brake pipe reduction necessary at the brake-valve for a certain brake cylinder pressure, due to the fact (1) that part of the reduction takes place at each triple valve, and (2) that the air taken from the brake pipe into the brake cylinder gives a little higher pressure than if the auxiliary reservoir pressure alone were admitted, thus requiring a smaller brake pipe reduction for the same cylinder pressure.

Full Service Position. With short trains the brake pipe volume, being comparatively small, will reduce more rapidly for a certain reduction at the brake-valve than with long trains. Under such circumstances the added reduction at each triple valve by the quick service feature might bring about so rapid a brake pipe reduction as to cause quick action and an emergency

application, when only a light application was intended. But this is automatically prevented by the triple valve itself. From Fig. 9 it will be noted that in the quick service position port *z* in the slide-valve and port *r* in the seat do not fully register. Nevertheless the opening is sufficient to allow the air to flow from the auxiliary reservoir to the brake cylinder with sufficient rapidity to reduce the pressure in the auxiliary reservoir as fast as the pressure is reducing in the brake pipe, when the train is of considerable length. But if the brake pipe reduction is more rapid than that of the auxiliary, the difference in pressures on the two sides of piston 4 soon becomes sufficient to compress the graduating spring slightly and move the slide-valve to the position shown in Fig. 12. In this psition quick service port *y* is closed, so that no air flows from the brake pipe to the brake cylinder.

The brake pipe reduction being sufficiently rapid there is no need of the additional quick service reduction, so the triple valve cuts it out. Also ports *z* and *r* are fully open and allow the auxiliary reservoir pressure to reduce more rapidly, so as to keep pace with the more rapid brake pipe reduction.

Lap Position. When the brake pipe reduction ceases air continues to flow from the auxiliary reservoir through ports *z* and *r* to the brake cylinder, until the pressure in chamber R becomes less than that of the brake pipe to cause piston 4 and graduating valve 7 to move to the right until the shoulder on the piston stem strikes the left-hand end of slide-valve 3. As the friction of piston and graduating valve is much less than that of the slide-valve, the difference in pressure which will move the piston and the graduating

valve will not be sufficient to move all three; consequently the piston stops in the position shown in Fig. 10. This movement has caused the graduating valve to close port *z*, thus cutting off any further flow of

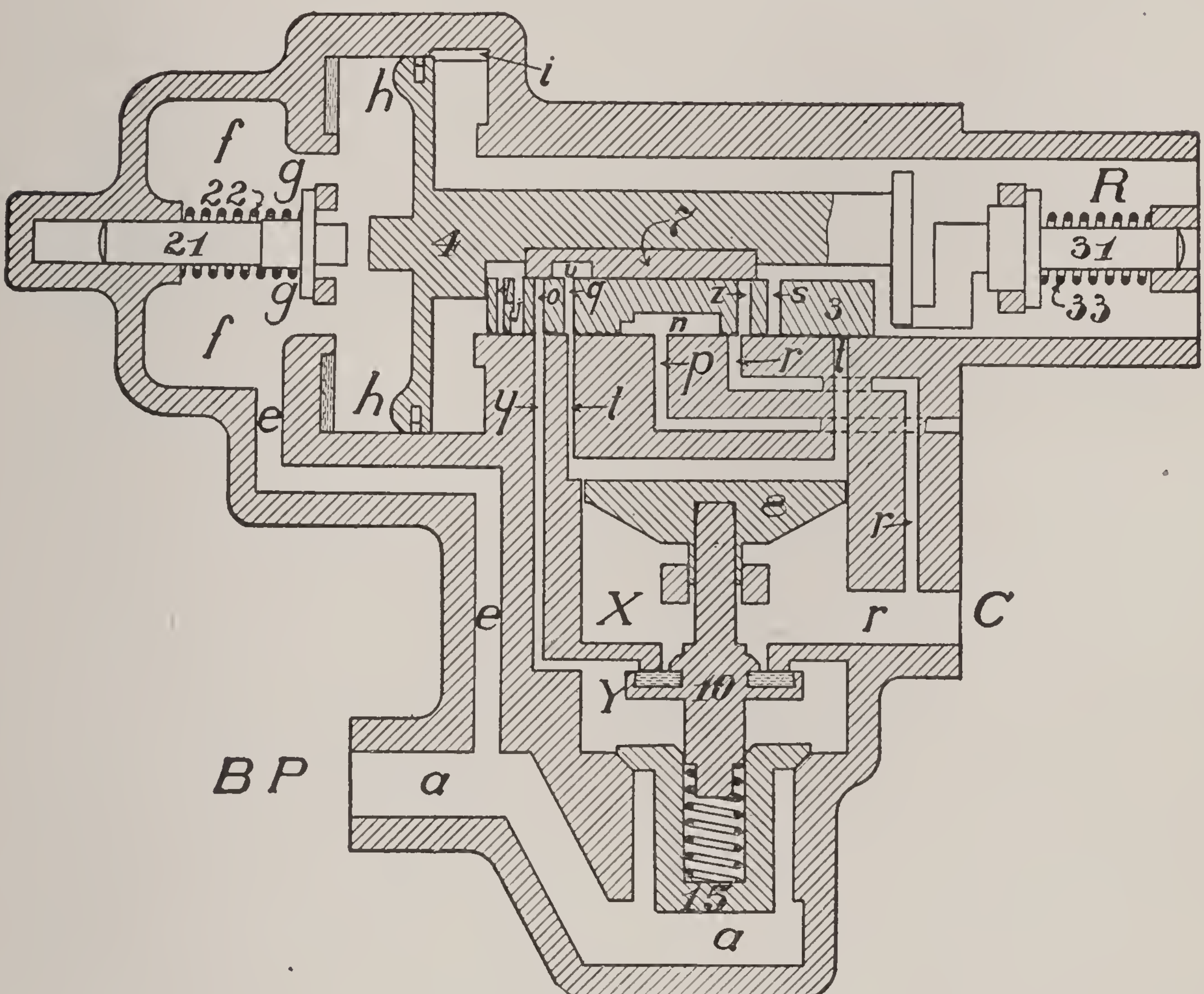


Fig. 10.
Lap Position.

air from the auxiliary reservoir to the brake cylinder. Consequently no further change in air pressure can occur, and this position is called "lap" because all ports are lapped; that is, closed.

If it is desired to make a heavier application a further reduction of brake pipe pressure is made, and the

operation described above repeated until the auxiliary reservoir and brake cylinder pressures become equal, after which any further brake pipe reduction is only a waste of air. About twenty pounds brake pipe reduction will give this equalization.

Retarded Release and Charging Position. The K triple valve has two release positions, full release and retarded release. Which one of its ports will move when the train brakes are released depends upon how the brake pipe pressure is increased. If slowly, it will be full release, and, if quickly and considerably, it will be retarded release.

It is well known that in freight train service when the engineer releases the brakes the rapidity with which the brake pipe pressure increases on any car depends on the position of the car in the train. Those cars towards the front receiving the air first will have their brake pipe pressure raised more rapidly than those in the rear with the old standard apparatus. This is due to two things, (1) the friction in the brake pipe; (2) the fact that the auxiliary reservoirs in the front at once begin to recharge, thus tending to reduce the pressure head by absorbing a quantity of air and holding back the flow from the front to the rear of the train. The retarded release feature of this new triple valve overcomes the second point mentioned, taking advantage of the first while doing so. The friction of the brake pipe causes the pressure in chamber *h* to build up more rapidly on triple valves toward the front than those in the rear. As soon as its pressure is enough greater than auxiliary reservoir pressure remaining in chamber R after the application above described to overcome the friction of the pis-

ton, graduating valve and slide-valve, all three are moved toward the right until the piston stem strikes the retarding device stem 31. The latter is held in position by the retarding device spring 33. If the rate of increase of the brake pipe pressure is small, as, for

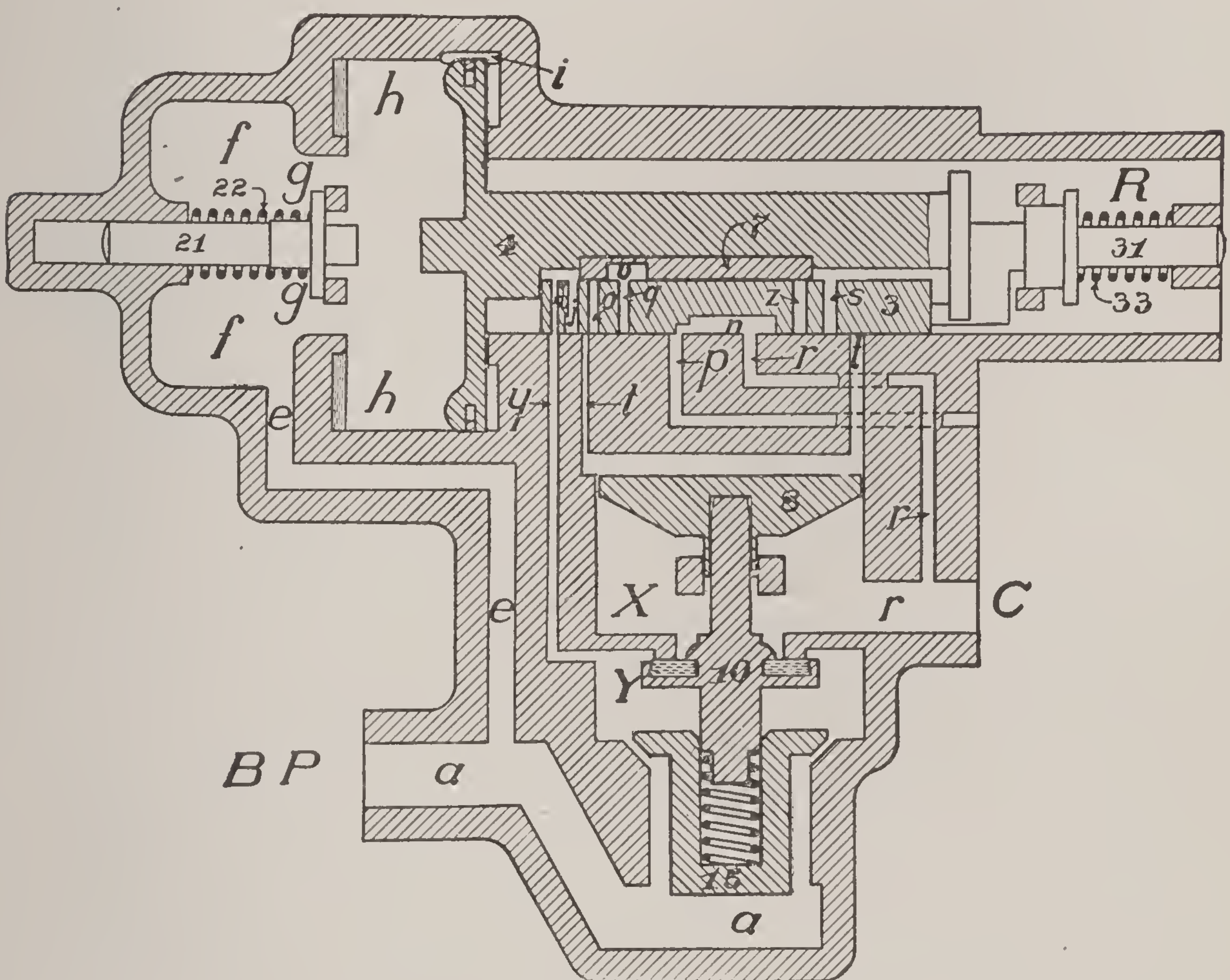


Fig. 11.
Retarded Release Position.

example, when the car is near the rear of the train, the triple valve parts will remain in this position, as shown in Fig. 8, the brakes will release and the auxiliary reservoirs recharge as described under "Full Release and Charging." If, however, the triple valve is near the head of the train and the brake pipe pres-

sure builds up more rapidly than the auxiliary reservoir can recharge, the excessive pressure in chamber *h* will cause the piston to compress retarding device spring 33 and move the triple valve parts to the position shown in Fig. 11.

Exhaust cavity *n* in the slide-valve 3 connects port *r* leading to the brake cylinder with port *p* to the atmosphere, and the brake will release; but as the small extension of cavity *n* (Fig. 11) is over port *p* discharge of air from the brake cylinder to the atmosphere is quite slow. In this way the brakes on the front end of the train require a longer time to release than those on the rear. This feature is called the "Retarded Release," and, although the triple valves near the locomotive commence to release before those in the rear, as is the case with the old type triple valve, yet the exhaust of brake cylinder pressure in retarded release position is sufficiently slow to allow the rear brakes to release first. This permits of releasing the brakes on very long trains at low speeds without danger of a severe shock or break-in-two.

At the same time the back of the piston is in contact with the end of the slide-valve bushing and, as these two surfaces are ground to an accurate fit, their contact effectually cuts off communication between chambers *h* and R through feed groove *i*, preventing air from feeding through from the brake pipe to the auxiliary reservoir by this path. Also port *l* in the slide-valve registers with port *y* in the slide-valve seat, and pressure in chamber Y can flow through ports *y* and *l* to chamber R and the auxiliary reservoir. Chamber Y is supplied with air under these circumstances by the check-valve 15 raising and allowing brake pipe air to flow past it. The area of port *l* is about half that of feed groove *i*, so that the rate

at which the auxiliary reservoir will recharge is much less than when the triple valve is in full release position.

As the auxiliary reservoir pressure rises and the pressures on the two sides of piston 4 become nearly equal, retarding device spring 31 forces the piston, slide-valve, graduating valve and retarding device stem back to the full release position, shown in Fig 8, when the remainder of the release and recharging will take place as previously described under "Full Release and Charging."

These features of the new valve are always available, even when mixd in trains with the old standard, the beneficial results being in proportion to the number of new valves present.

Emergency Position. Emergency position is the same with the K triple valve as with the old type. Quick action is caused by a sudden and considerable reduction in brake pipe pressure, no matter how caused. This fall in brake pipe pressure causes the difference in pressures on the two sides of piston 4 to increase very rapidly, so that the friction of the piston, slide-valve and graduating valve is quickly and easily overcome, and they move to the left with such force that when the piston strikes the graduating stem it compresses graduating spring 22, forcing back the stem and spring until the piston seats firmly against gasket 23, as shown in Fig. 12. The movement of the slide-valve opens port *t* in the slide-valve seat and allows auxiliary reservoir pressure to flow to the top of emergency piston 8, forcing the latter downward and opening emergency valve 10. The pressure in chamber Y being instantly relieved allows brake pipe air to raise the check-valve 15 and flow rapidly through chambers Y and X to the brake cylinder, until brake cylinder and brake pipe pressures equalize, when

both check-valve and emergency valve are forced to their seats by the spring in the former, preventing the pressure in the cylinders from escaping back into the brake pipe. At the same time port *s* in the slide-valve registers with port *r* in the slide-valve seat, and allows auxiliary reser-

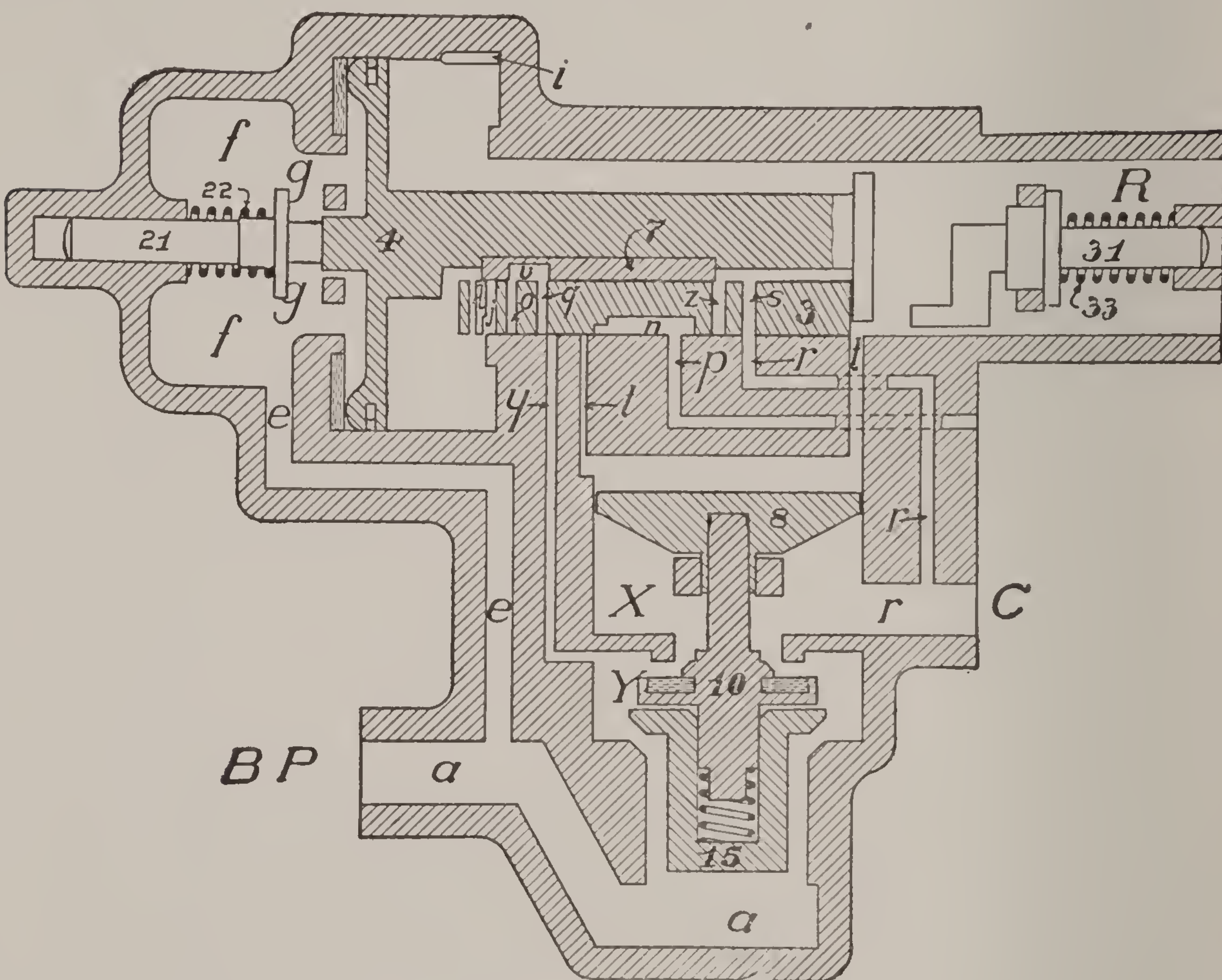


Fig. 12.
Emergency Position.

voir pressure to flow to the brake cylinder. But the size of ports *s* and *r* is such that very little air gets through them before the brake pipe pressure has stopped venting into the brake cylinder. This sudden discharge of brake pipe air into the brake cylinder has the same effect on the next triple valve as would be caused by a similar dis-

charge of brake pipe air to the atmosphere. In this way each triple valve applies the next, thus giving the quick and full application through the greater amount of brake pipe air admitted to the brake cylinders. The rapidity with which the brakes apply throughout the train is so much increased that in a fifty car train it requires less than three seconds; the brake cylinder pressure is also increased approximately twenty per cent.

The release after an emergency is affected in exactly the same manner as after a service application, but it requires longer time, owing to the higher brake cylinder pressures and lower brake pipe pressures.

THE WESTINGHOUSE TRAIN AIR SIGNAL SYSTEM

PRESSURE REDUCING VALVE.

The pressure reducing valve is a valve connected to the main reservoir and used for supplying air to the signal system at a lower pressure than that in the main reservoir. The best results are obtained by using a pressure of forty pounds, which is considered standard.

A short, quick exhaust or reduction is necessary to cause the whistle to sound properly. The signal valve operates on the same principle as the quick action part of the triple valve, which is thrown into operation by a short, quick exhaust, while a longer though a more gradual reduction would cause only a service application. With the signal apparatus a short, quick reduction will cause the whistle to respond, while a long, gradual reduction will not cause it to sound.

When a slow, gradual reduction of the signal line pressure is made, instead of reducing the pressure in the signal line below that in the chamber under the diaphragm, the pressure feeds from this chamber back into the signal line, thus removing the power that should operate the diaphragm or signal valve. This action is also assisted by the pressure reducing valve, which is open and feeding into the signal line at all times when the pressure is reduced below forty pounds.

Fig. 4, Plate 1, is a vertical sectional view of the improved signal reducing valve. The operative parts of the reducing valve are Supply Valve 4, Supply Valve Spring 6, Reducing Valve Piston 7, Piston Rod 10, Diaphragm 11 and Regulating Spring 13.

Operation of the Reducing Valve. The normal position of the reducing valve is open as shown in Fig. 4, Plate 1. When the valve is in this position air enters from the main reservoir at connection A; the supply valve being off its seat permits the air to pass by the seat of this valve into diaphragm chamber C, thence through port *b* to the signal pipe connection B.

The signal line pressure is present at all times on the diaphragm, and when the desired pressure in the signal line is attained it exceeds the tension of regulating spring 13 and the diaphragm is forced to its lower position, permitting supply valve spring 6 to seat supply valve 4, thus shutting off the flow of air from the main reservoir to the signal line.

The purpose of the cut-out cock is to afford a means of cutting off the main reservoir pressure from the supply valve whenever it is necessary to remove the valve for any purpose, with pressure in the main reservoir.

After the air has passed through the reducing valve it passes to the signal line throughout the entire train and also to the whistle signal valve, causing it to become charged.

SIGNAL VALVE.

Fig. 1, Plate 1, is a sectional view of whistle signal valve in its normal position. The purpose of this valve is to regulate the flow of air to the signal whistle. The

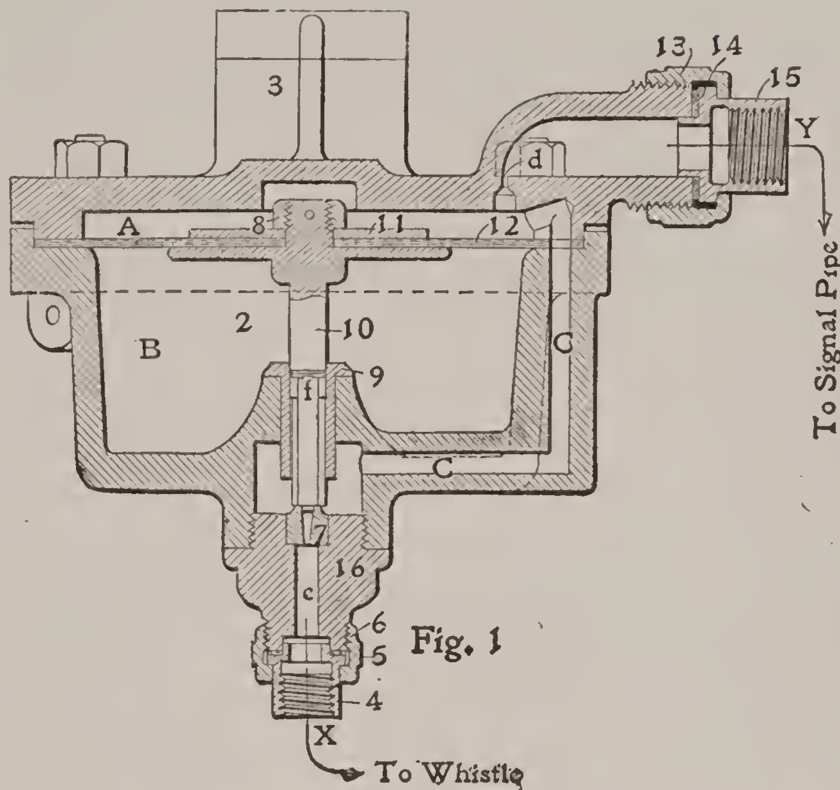


Fig. 1

Fig. 3

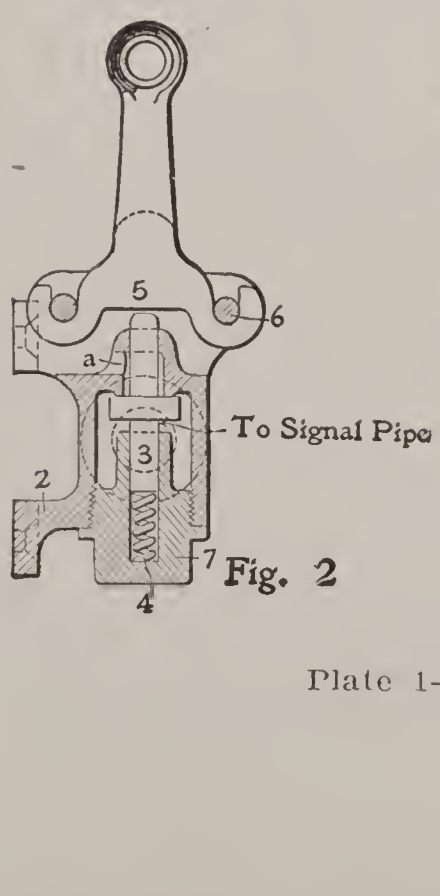


Fig. 2

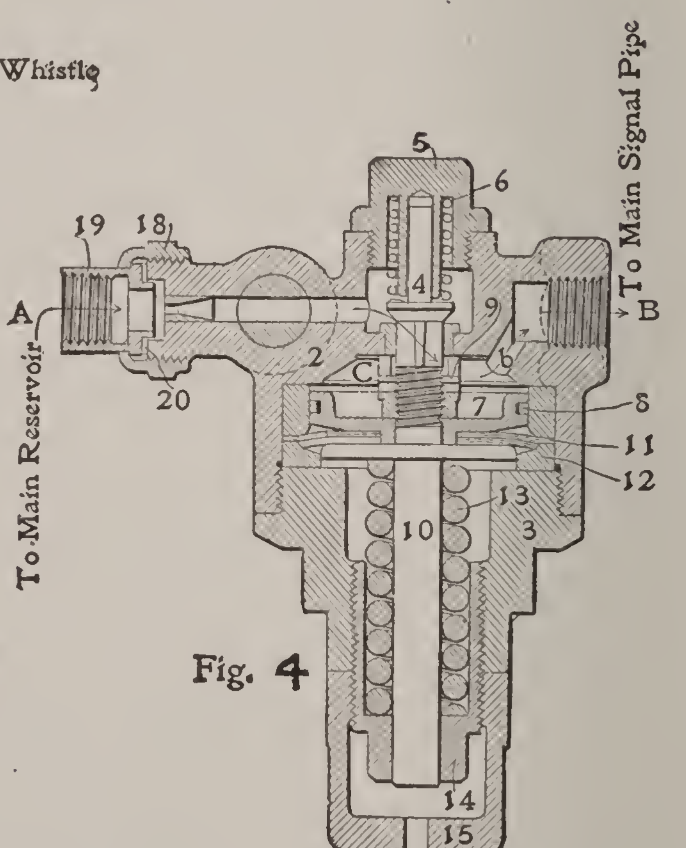


Fig. 4

Plate 1—Figres 1-2-3 and 4.

two compartments A and B are separated by diaphragm 12, and diaphragm stem 10 secured thereto extends through bushing 9, its lower end acting as a valve on seat 7 of cap nut 16, above passage e. Diaphragm stem 10 fits bushing 9 snugly for a short distance below its upper end, to where a peripheral groove is cut in the stem below which it is milled in triangular form.

Operation. While the system is being charged, air enters the valve from the signal line, passes through port *d* into chamber A, above the diaphragm; also through port C and around piston stem 10 into chamber B, causing the air pressure to equalize above and below diaphragm 12. When a quick reduction is made in the signal line it causes a reduction of pressure in chamber A, above the diaphragm. The pressure in chamber B then being the greater causes the diaphragm to raise, lifting signal valve 10 off its seat. The air pressure in chamber B passes by diaphragm stem 10 and unites with the air pressure passing through port C, thence through port e, below the valve-stem, into the pipe leading to the whistle, which causes a blast. The same reduction of signal line pressure which causes the signal valve to operate also causes the reducing valve to open, which permits main reservoir pressure to flow into the signal line, restoring the pressure. This raises the signal line pressure and also causes pressure to be raised in chamber A, above the diaphragm, moving it to its lower position, as shown in Fig. 1. Equilibrium of pressure quickly occurs in chambers A and B, and the valve at the lower end of stem 10 returns to its seat.

THE CAR DISCHARGE VALVE.

The car discharge valve is usually located outside the car, above the door, and opposite the opening through which the signal cord passes. A branch pipe extends from the main signal pipe to the car discharge valve, and in this pipe is placed a one-half inch cock, by means of which the valve on the car may be cut out when desired.

The pressure in the signal line is reduced by means of the car discharge valve and can be operated from any part of the car by means of a cord known as the whistle cord.

Operative Parts. The operative parts of the car discharge valve are the Discharge Valve 3, Discharge Valve Spring 4, and Discharge Valve Handle 5. The normal position of this valve is closed, as shown in Fig. 2, Plate 1.

Operation. The valve is operated by means of valve handle 5, which is in the form of a lever. By moving this lever in either direction it forces discharge valve 3 from its seat, which compresses discharge valve spring 4, thus permitting air pressure to escape from the signal line to the atmosphere.

When operating the air whistle signal the car discharge valve should be held open for at least one second in order to produce a proper blast of the whistle.

An intermission of about three seconds should be allowed between blasts on trains of five cars or less and one second should be added for each additional car in the train. The spacing of the blasts is necessary in order to give the air pressure in the signal valve sufficient

time to equalize above and below the diaphragm of the signal valve between each blast of the whistle.

DEFECTS OF THE AIR SIGNAL SYSTEM.

Failing to Charge. If the signal line fails to charge it should first be noted that it is cut in between the tank and the first car and all angle cocks on the train are open, except the one on the rear end of the train, which should be closed, and that the reducing valve is cut in and properly adjusted. If the trouble still continues it may be due to the choke in the reducing valve becoming stopped up so that no air can pass through, a collapsed hose lining which would block the passage or, in cold weather, the signal line between the tank and engine may be frozen.

Failure of Whistle to Sound. If the signal line is properly charged and an exhaust occurs at the discharge valve when the whistle cord is pulled properly, but the whistle fails to give a blast, the trouble may be due to the strainer in the tee-pipe connection of the branch pipe to the signal line being partly stopped up; port *d* of the signal valve being stopped up so that no air can enter to charge it; stem 10 of the signal valve becoming worn sufficiently loose in bushing 9 to allow the pressure in chamber B to reduce as rapidly as that in chamber A; the signal valve diaphragm becoming baggy or having a hole in it; the passage in bushing 7 becoming stopped up, or stem 10 fits too tightly in bushing, not allowing chamber B to charge; the bell of the signal whistle not being properly adjusted or its bowl filled with dirt; the whistle being located so that the wind blowing across the bowl from an open cab

window preventing it from sounding, or the choke in the reducing valve being too large, allowing the signal line to be charged as fast as the reduction is being made.

One Long Blast. If the air whistle gives one long blast it may be due to the reductions being made too close together or diaphragm stem 10 working stiffly in bushing 9, in which event the passage at *e* would remain open until a sufficient difference of pressure existed in chambers A and B to force stem 10 to its seat.

Two or More Blasts. If the air whistle gives two or more blasts each time the cord is pulled the trouble is due to a stiff diaphragm or diaphragm stem 10 fitting too loosely in bushing 9, in which event the reduction in chamber A would allow chamber B to respond too quickly and reduce its pressure below that in chamber A, causing chamber A pressure to force stem 10 to its seat, nd this would be repeated several times during one reduction of chamber A pressure.

Whistle Sounding When Brakes are Released. If the air whistle gives a blast each time the brakes are released it indicates that the signal line pressure is charged up to that in the main reservoir, which is caused by the tension of the regulating spring being too great, the supply valve of the reducing valve being held from its seat, or a leak past the diaphragm, and the opening in the spring casing stopped up.

When the signal line is overcharged it can be detected from the train by a strong discharge of air from the discharge valve, and on the engine by the signal whistle, as the bell of the whistle is adjusted for a pressure of forty pounds instead of ninety.

Testing Signal Line Pressure. A test of the pressure in the signal line can be made from the engine without the use of a test gauge by shutting off the air pump, gradually reducing the main reservoir pressure and watching the red hand of the air gauge. When the whistle blows the air gauge will indicate the pressure in the signal line.

COMBINED FREIGHT CAR CYLINDER AND AUXILIARY RESERVOIR WITH TRIPLE VALVE ATTACHED.

The combined freight car cylinder and reservoir (Fig. 13) is the usual form of equipment applied to freight cars. On a part of the cars in use the cylinders and auxiliary reservoirs are separated, but the triple valve, auxiliary reservoir and brake cylinder are the same in both cases. The auxiliary reservoir 10 is simply a hollow shell for the purpose of storing air for use in the brake cylinder upon the same car. Pipe *b* provides communication between the triple valve and the brake cylinder. Upon passenger cars this pipe does not pass through the auxiliary reservoir, but the operation of the brake is the same—it is simply a different arrangement of the same parts.

Fig. 14 shows a sectional view of the passenger car brake cylinder with special head and triple valve attached to it, in the same manner in which the triple is connected to the auxiliary on freight equipment.

List of Parts and Their Purposes. 2 is the brake cylinder; 3 is the piston and sleeve in which the push rod connected with the system of brake levers is inserted; 4 is the non-pressure cylinder head; 9 is the release spring, which forces piston 3 to release position when the air pressure is released from the pressure end of the cylinder; 7 is a packing leather, which is pressed against the cylinder wall to prevent air from escaping past

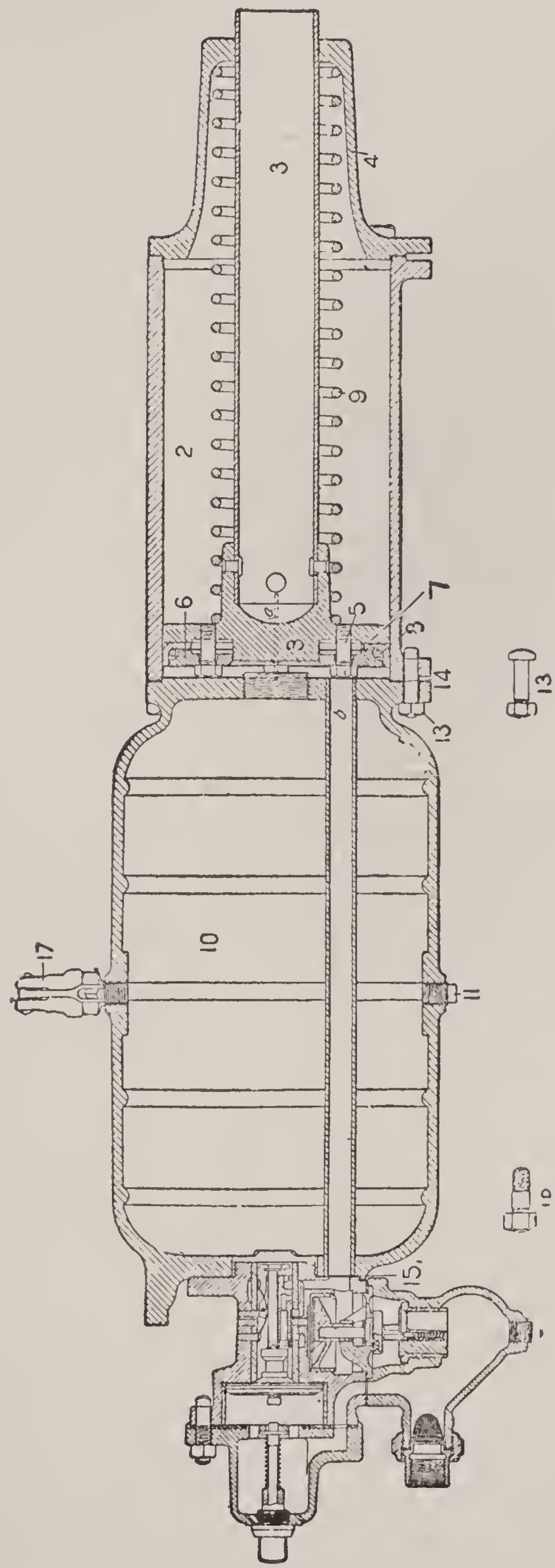
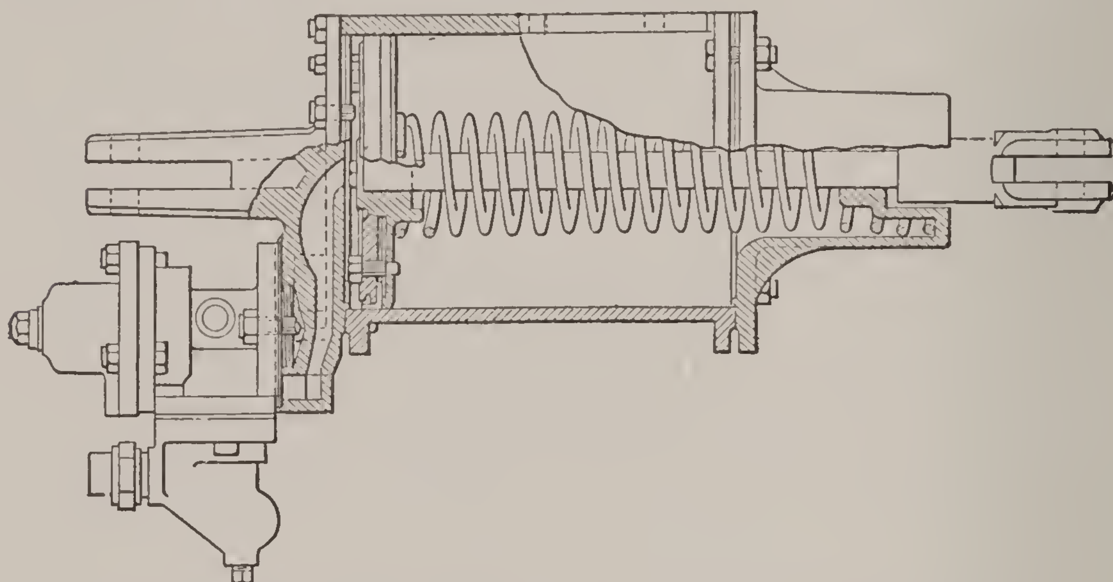


Fig. 13.

the piston; 8 is a round spring packing expander, which serves to hold the flange of the packing leather against the walls of the cylinder; 6 is the follower plate, which, by means of studs and nuts 5, clamps the packing leather to the piston; and *a* is a small groove, indicated by dotted lines in the wall of the cylinder, called the leakage groove.



Westinghouse Passenger Car Brake Cylinder and Triple Valve.

Fig. 14.

If the exhaust port on the slide-valve of the triple valve should in any manner become obstructed when it is not desired to have the brakes applied a slight flow of air into the brake cylinder will, instead of forcing the piston out, escape through leakage groove *a* to the atmosphere at the non-pressure end of the cylinder.

Valve 17, usually placed on the upper side of the auxiliary reservoir, is known as the release valve. A rod extends from the arms of this valve to each side of the car. Pulling either rod unseats the valve and discharges air from the reservoir for the purpose of releasing the brake.

Sizes of Brake Cylinders. Brake cylinders with a diameter of six, eight, ten, twelve, fourteen and sixteen inches, and of various lengths, are used on cars of various

capacities. The size of the brake cylinder is determined by the total light weight of the car resting on the rails.

Sizes of Reservoirs. A reservoir 10x24 inches is required with eight inch cylinders on passenger cars; ten-inch cylinders are used with 12x33 reservoirs on passenger equipment; twelve-inch cylinders are used with 14x33inch reservoirs, passenger equipment; fourteen-inch cylinders with 16x33-inch reservoirs with engine, tender and passenger equipment, while with a sixteen-inch cylinder on passenger equipment a reservoir 16x42 inches is used. For freight car equipment, on which cylinders six, eight and ten inches in diameter are used, a standard cast iron reservoir of different sizes adapted to each size of cylinder must be used.

DEFECTS OF THE BRAKE CYLINDERS.

Any leakage from the brake cylinder will cause the brake to release. This is usually caused by the packing leather becoming cut or very dry and not forming an air-tight joint between the piston and the cylinder wall.

If the expanding ring is not placed in its proper position the packing leather will not be held against the cylinder wall, thus permitting a leakage. In some cases it will also bind the piston, preventing it from returning to release position after the pressure has been exhausted.

A broken or weak piston release spring will fail to force the piston to its normal or release position after the pressure has been exhausted from the cylinder.

If the leakage groove becomes stopped up, and the exhaust port is obstructed, it will possibly cause the brakes to set slowly if a leak exists to the brake cylinder, as the air that is admitted to the cylinder cannot escape past the piston.

AUTOMATIC SLACK ADJUSTER

The automatic slack adjuster is a simple mechanism, by means of which a predetermined piston travel is constantly maintained, compelling the brakes of each car to do their full amount of work, thus securing from the brakes their highest efficiency, eliminating the danger of causing flat wheels, which is likely to occur with a wide range of piston travel. This device establishes the running piston travel, that is, the piston travel when the brakes are applied while the car is in motion and, since this is the time during which the brakes perform their work, the running travel is the important one. Hand adjustment of brakes necessarily relies upon the standing travel, and it is only coarsely graded by the spacing of the holes in the dead lever guides.

Operation. The slack adjuster is shown in Figs. 15, 16 and 17. The brake cylinder piston acts as a valve to control the admission and release of brake cylinder pressure to and from pipe *b* (Fig. 15, through port *a* in the cylinder. Port *a* is so located that when the piston uncovers port *a*, brake cylinder air flows through pipe *b* into slack adjuster cylinder 2, where the small piston 19 (Fig. 16) is forced outward, compressing spring 21. Attached to piston stem 23 is a pawl extending into casing 24, which engages ratchet wheel 27, mounted within casing 24, upon screw 4 (Fig. 15). When the brake is released and the brake cylinder piston returns to its normal position the air pressure in cylinder 2 escapes to the atmosphere through pipe *b*, port *a* and the non-pressure head of the brake cylinder, thus permitting spring 21 (Fig. 16) to force the small piston to its normal position.

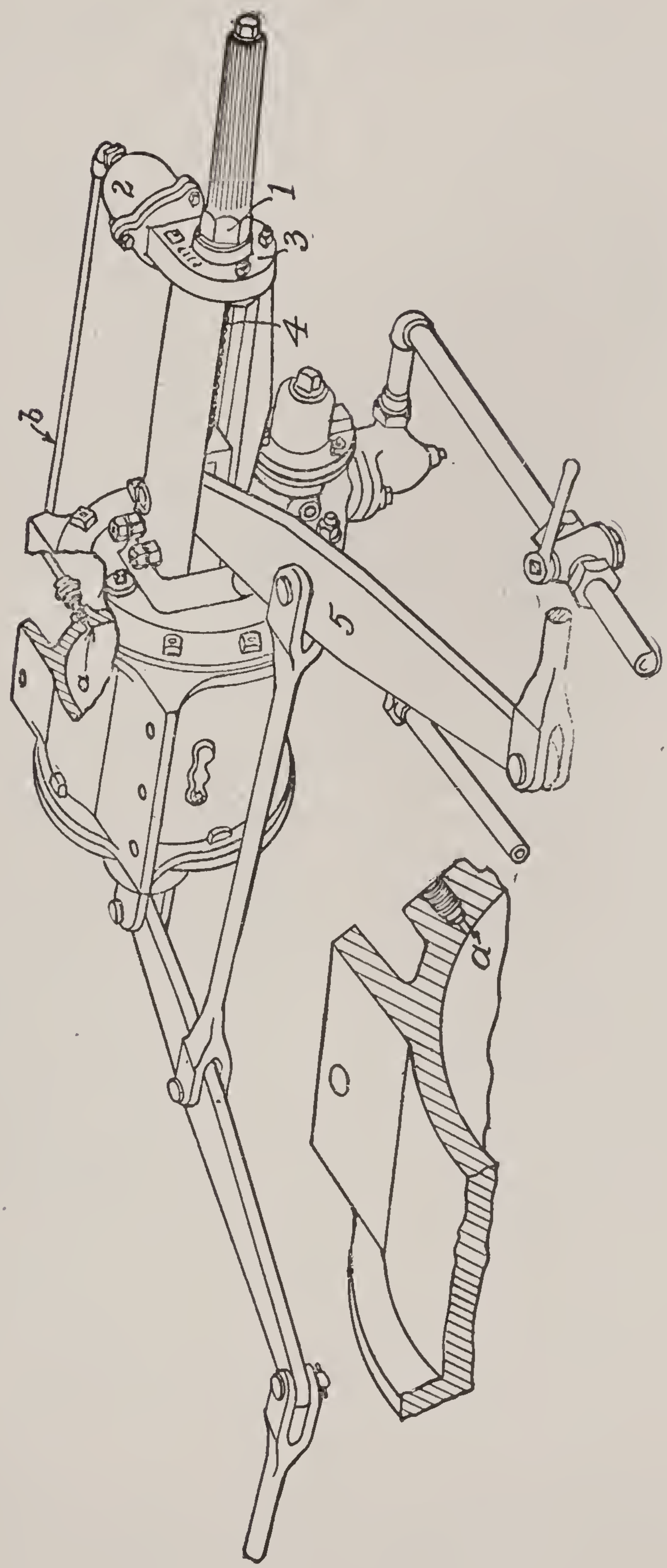
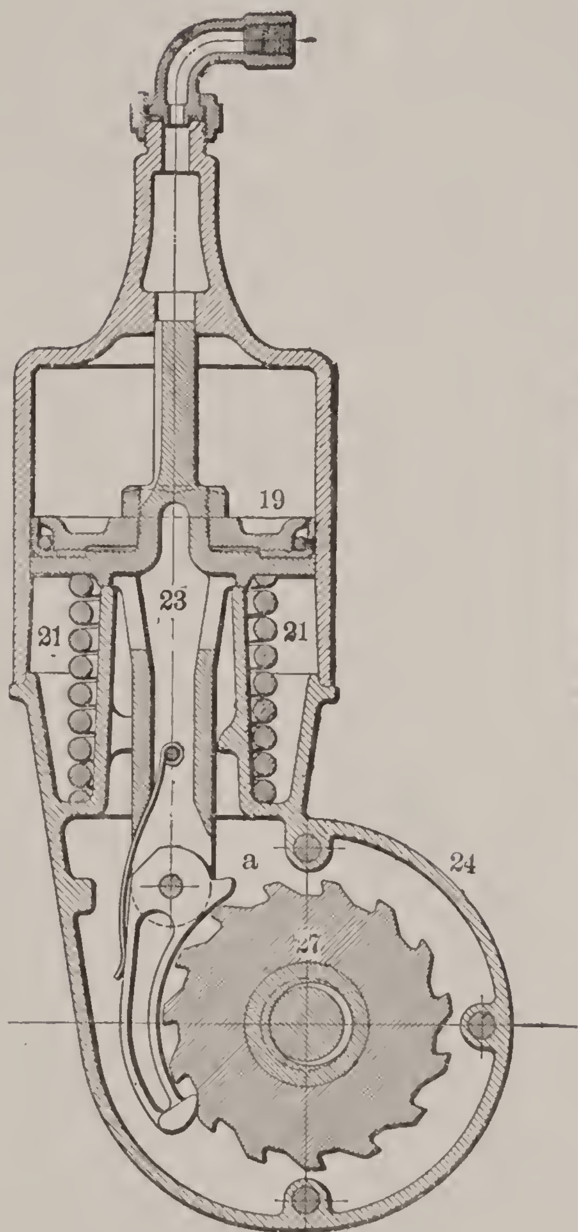


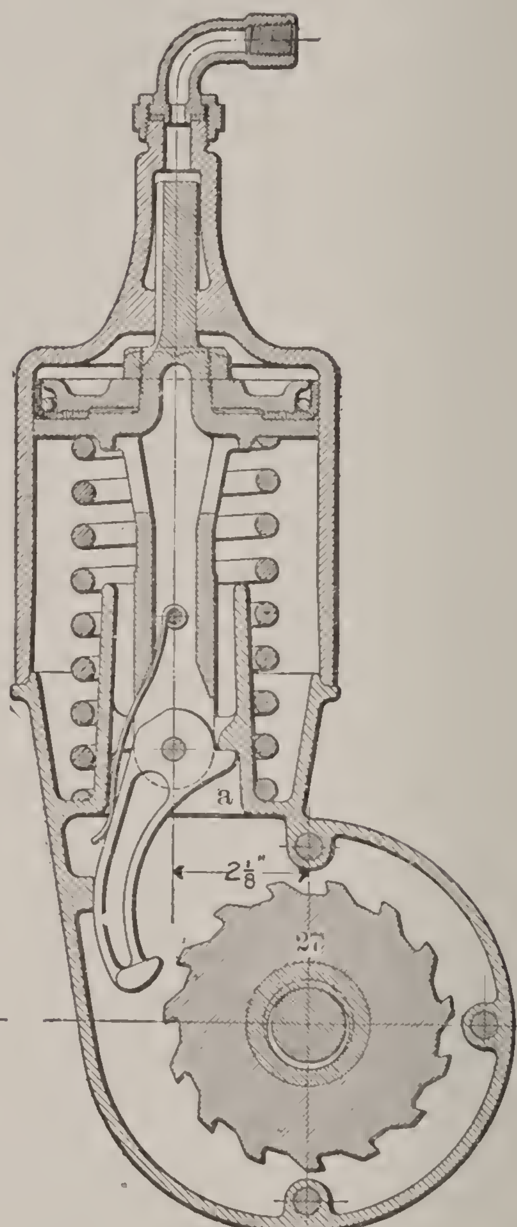
Fig. 15.

In so doing the pawl turns the ratchet wheel upon screw 4 and thereby draws lever 5 slightly in the direc-



APPLIED

Fig. 16.



RELEASED

Fig. 17.

tion of the slack adjuster cylinder, thus shortening the piston travel and forcing the brake-shoe nearer the

wheels. As the pawl is drawn back to its normal position a lug on the lower side strikes projection *a* (Fig. 17) on the cylinder, thus raising the outer end of the pawl, disengaging it from the ratchet wheel and thus permitting the screw to be turned by hand if desired. The screw mechanism is so proportioned that the piston travel is reduced only about one thirty-second inch by each operation, which removes the danger of unduly taking up false travel.

Improper Adjustment. If the piston travel is found to be too long when the small pipe leading to the adjuster cylinder is free from obstruction and the packing leather in the adjuster cylinder is free from leakage, it is more than probable that the slack has been taken up through an application, with only partial release of the hand brakes, and full release occurring only after the shoes have had time to wear. If the piston travel becomes too short it will be found that some of the slack in the brake rigging has been taken up by the hand brake where the two work in opposition or the dead levers have been moved.

Purpose of the Slack Adjuster. The purpose of the slack adjuster is to maintain a predetermined piston travel, as by constant wear the brake-shoes become thinner, which causes the brake piston to travel further and results in reducing the brake cylinder pressure and the holding power of the brake.

The automatic adjuster regulates the piston to its proper running or working travel, regardless of the length of travel, or whether the car has high or low leverage. Therefore, if all cars in a train were equipped with automatic adjusters the travel of all pistons would be

uniform when the brakes were set to slow down or stop the train, the same brake cylinder pressure would be had on all cars at each and every reduction and all cars in the train would develop equal braking power.

As the work of the automatic adjuster is based on running travel the travel of the pistons will be uniform, but the standing travel of the pistons will not necessarily be uniform on all cars in the train.

PRESSURE RETAINING VALVES.

STANDARD RETAINING VALVE.

The standard type of pressure retaining valve used on six, eight and ten-inch cylinders is shown in Figs. 18 and 19. It consists of weighted valve 4, enclosed in cas-

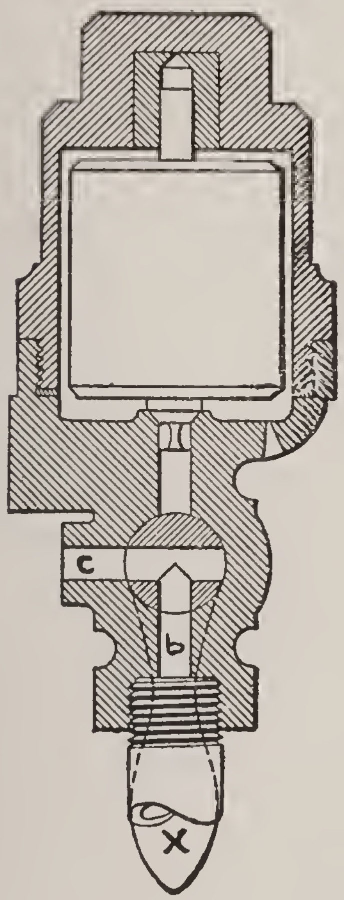


Fig. 18.

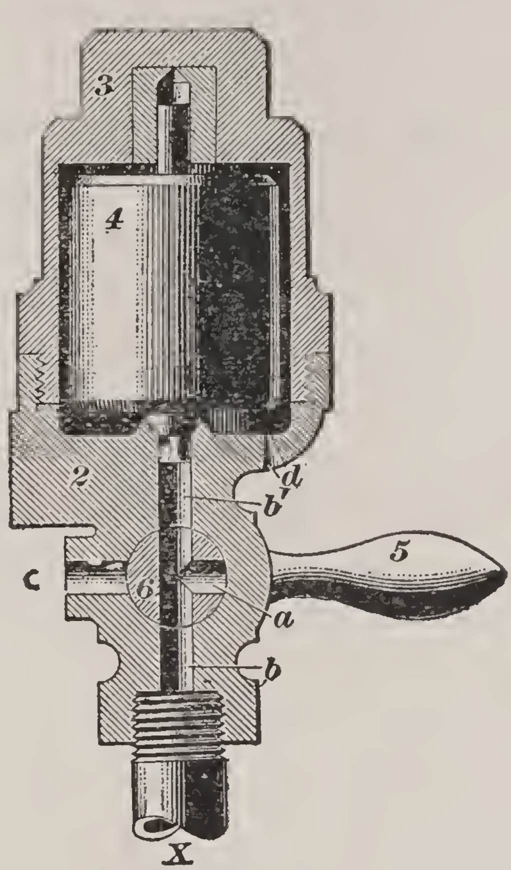


Fig. 19.

ing 3, and seating in passage *b*; this valve is screwed on to the further end of a pipe leading to the exhaust port of the triple valve.

Operation. When the handle of the pressure retaining valve is turned downward, pointing perpendicularly (Fig. 18) the pressure escapes from the brake cyl-

inder through the retaining valve pipe to the retaining valve, where it escapes freely to the atmosphere, entering the retaining valve at X, passing through ports *b* and *c* to the atmosphere. In this position the valve is not in operation and has no duty to perform.

When the handle of the retaining valve is turned upward, pointing horizontally, the direct outlet from the retaining valve pipe is closed. As shown in Fig. 19, the air is discharged from the brake cylinder through the triple valve, retaining valve pipe and ports *b, a* and *b,* as before. Port *c* now being closed, the air pressure must lift weighted valve 4 and pass to the atmosphere through the restricted port *d.* All pressure over fifteen pounds will hold the valve from its seat and escape through a small port in the cage. This valve is so proportioned that it will seat only when fifteen pounds or less pressure is exerted upon it. Thus the last fifteen pounds is retained in the brake cylinder, which is sufficient to steady the train while the auxiliary reservoirs are being recharged.

The retaining valve not only holds a braking power of fifteen pounds in the cylinders, but the passageway out of the casing to the atmosphere is restricted to such an extent that a considerable time is consumed in discharging the brake cylinder pressure through the small port. This renders the release of the brake much slower and exerts a retarding effect, which gives more time for the recharging of the auxiliary reservoir.

Difference in Sizes of Port *d.* Port *d* is not the same size on all retaining valves. It is one-sixteenth inch on the retaining valves used on six, eight and ten-inch cylinders and one-eighth inch in those used with twelve, fourteen and sixteen-inch cylinders. These port sizes give a restriction which requires from thirty to sixty

seconds for the cylinder pressure to escape down to the amount limited by the weighted valve. The figures given cover the standard retaining valve. This has been found by repeated tests to be the standard pressure for cars in interchange service, and gives good results in braking on long grades without excessive heating of wheels. In mountain districts there are other types of retaining valves used to some extent, but they are not considered standard and are not in general use.

Advantages of the Retainer. The retaining valve also permits of a much safer handling of trains, the maintenance of a more uniform rate of speed down heavy grades and a saving of air pressure. It gives an increased cylinder pressure and a higher braking power with a lower consumption of air pressure, and in addition permits of a greater reserve in stopping power for emergencies.

The retaining valve cannot be used to advantage in driver brake operation. This is due to the fact that driving brake packing generally leaks and the various connections in the brake cylinder pipe frequently become loose, causing a leakage. With these avenues of escape for pressure the retaining valve is unable to perform its functions. The driver brake retaining valve has almost entirely given way to the combined automatic and straight air brake, which overcomes the leakage difficulties.

DEFECTS OF THE RETAINER.

If there is a steady leakage of pressure at the retaining valve when the brake is released the trouble will be found in the triple valve.

If the retaining valve handle has been turned upward

in a horizontal position, the brakes then released, and after a few moments the handle is turned downward and no air escapes, the trouble is not in the retaining valve, but is caused by a leaky joint or connection in the pipe or by the valve being held from its seat by dirt. If there is no leakage it indicates a leak at the brake cylinder packing.

If air fails to pass through the retaining valve, with the handle turned down and the brakes remain set, the trouble should be looked for at the exhaust port, which may have become stopped up by an accumulation of dirt.

THE HIGH AND LOW PRESSURE RETAINING VALVE.

The great value of the standard pressure retaining valve in the safe handling of trains on heavy grades has been demonstrated repeatedly. The growing severity of modern braking conditions, as a result of which average loads of seventy-three tons per brake on trains of twenty-five or more cars over grades of two hundred feet to the mile are frequently encountered, has brought about several methods for increasing the certainty of controlling such heavily loaded trains; one by raising the brake pipe pressure from seventy to ninety pounds, which gives a greater reserve for a re-application after release; another by increasing the percentage of braking power and using the standard pressure retaining valve; a third by the introduction of a special pressure retaining valve.

The standard retaining valve is designed to maintain a brake cylinder pressure of fifteen pounds while the auxiliary reservoirs are being recharged, and ordinarily this pressure is sufficient. Under extreme conditions,

however, it has proved desirable to increase the amount of pressure retained in the brake cylinders during the recharge of the auxiliary reservoirs to thirty and sometimes fifty pounds. This condition has been met by the

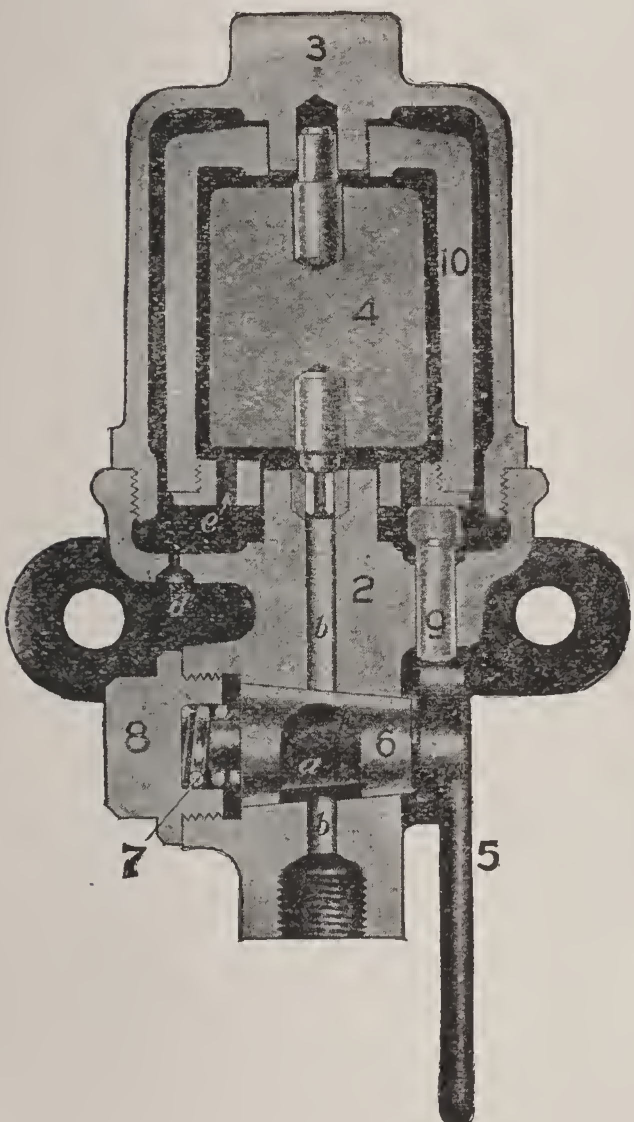


Fig 20.

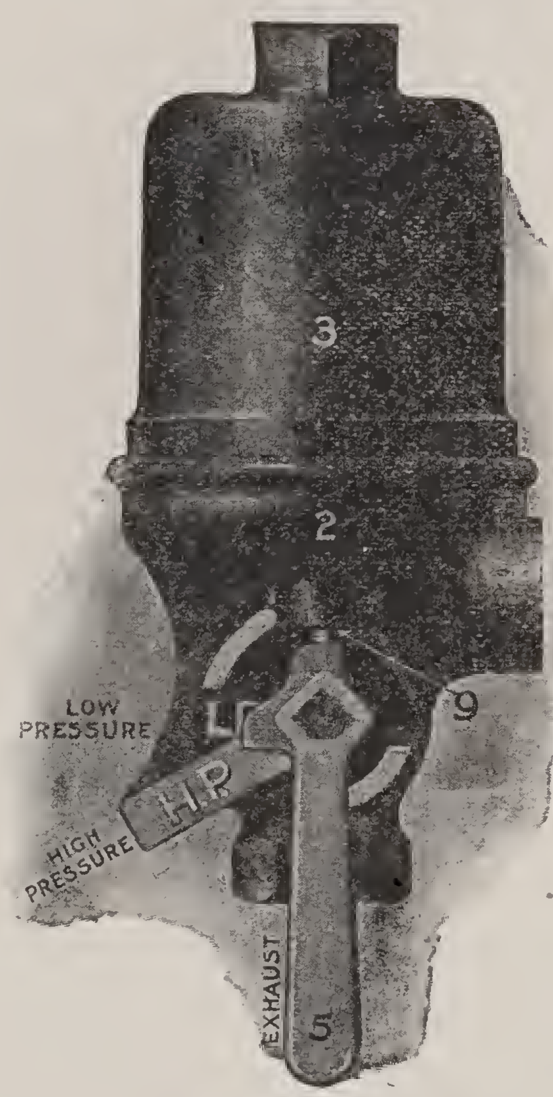


Fig. 21.

manufacture of a high and low pressure retaining valve which fully meets these requirements. It will be understood that this valve is only an accessory to the regular brake apparatus and is not intended to replace the more important factors required in heavy freight service, such as adequate braking power, proper size cylinders, suitable

leverage and the exercise of good judgment in the maintenance and operation of the brakes.

Operation. This new retaining valve is very similar to the standard type in general design and location, but is modified an indicated in Figs. 20 and 21. The main difference consists in the addition of a cylindrical weight 10, which surrounds the usual weight, and is lifted by it whenever valve handle 5 is manipulated to retain thirty pounds. When handle 5 is placed in the horizontal position one of two eccentric lugs on it raises pin 9 and also outer weight 10, the latter to the top of its movement. During such time inner weight 4 alone retains the pressure.

If the handle is placed in the intermediate position marked "high pressure" (Fig. 21) neither eccentric lug nor handle 5 touches lifting pin 9, and consequently outside weight 10 rests upon the top of inner weight 4 and the air pressure must raise both weights before it can escape to the atmosphere. When the handle is placed vertically as shown in Fig. 20, the air passes directly to the atmosphere, thus cutting out the retaining valve, while at the same time the other eccentric lug on the handle raises the lifting pin and outside weight so that the small weight alone rests on the valve-seat.

Positions of the Handle. The exhaust and low pressure positions of this retaining valve are similar to those of the standard retaining valve. Thus, when cars equipped with this valve are running in localities free from heavy grades, where the train crews are familiar only with the standard valve, they cannot by mistake place the handle in the high pressure position. The letters "H. P." and "L. P.," indicating respectively high pressure and low pressure, are cast on the body of the valve

so as to still further assist in indicating the positions of the valve handle.

The development of this retainer was coincident with a series of interesting and valuable tests made by a leading railway company with a view of determining what is actually required to hold heavy trains under perfect control when descending heavy grades, through using higher air pressure, special pressure retaining valves, water brake on the locomotive, and the combined automatic and straight air brake equipment on the engine and tender. The results of these tests indicate that to suitably control such trains, the minimum brake pipe and auxiliary reservoir pressures should not fall below seventy pounds, in order to give sufficient reserve braking power to stop the train on a heavy grade in case of necessity.

This at once necessitates an increase in air pressure throughout the system, as standard maximum brake pipe pressure is seventy pounds. Although this increase was provided, this change alone did not suffice to control the trains, and a special high and low pressure retaining valve was introduced, which was designed to retain a cylinder pressure of twenty-five pounds for use upon grades of two and one-half per cent or less and fifty pounds for grades approximately four per cent. It should be stated, however, that the conditions surrounding these tests were extreme, and that the high and low pressure retaining valves furnished as standard are proportioned for fifteen and thirty pounds respectively. This type of retainer is subject to the same defects as the standard retainer.

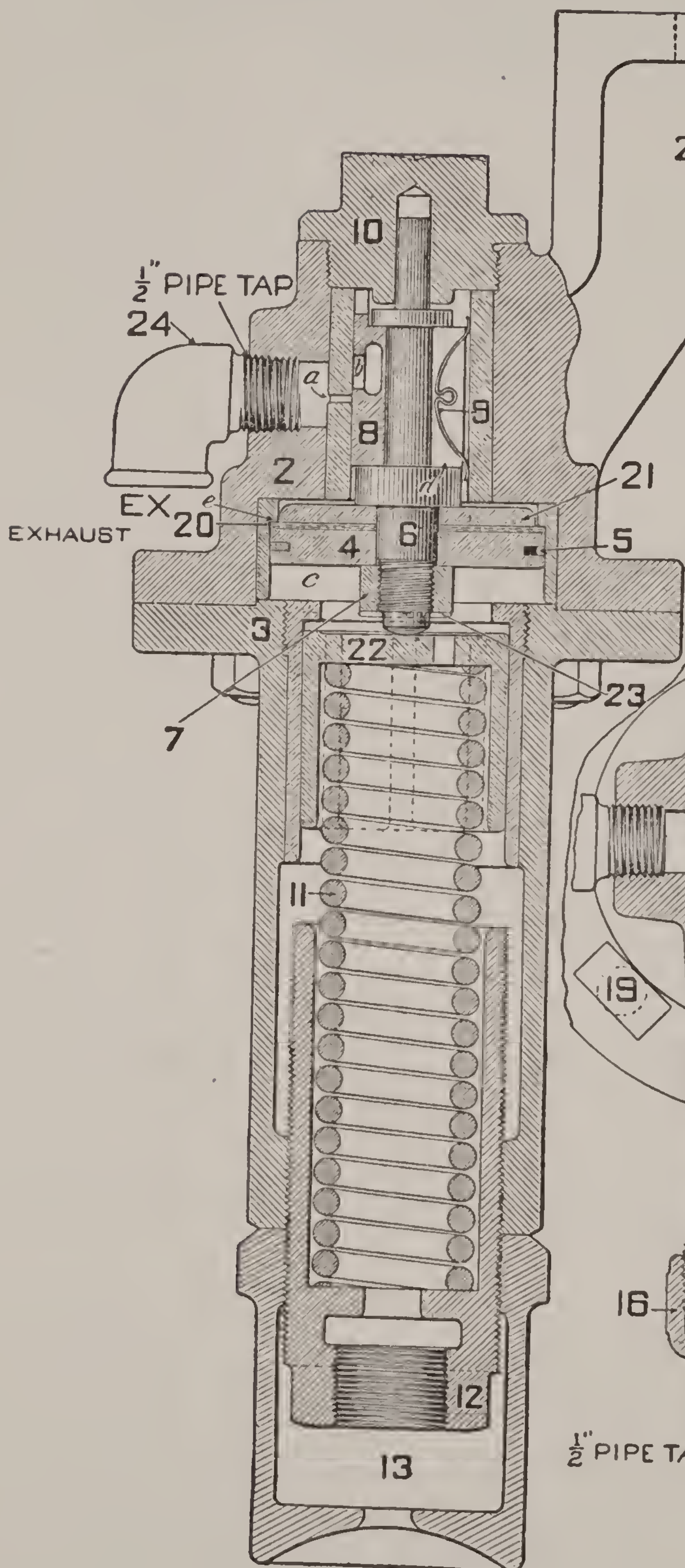
THE WESTINGHOUSE HIGH SPEED BRAKE.

The principles involved in the high speed brake are as follows: (1) The friction between the brake-shoes and the wheel, which tends to stop the rotation of the wheel, becomes less as the rapidity of the rotation of the wheel increases; (2) the adhesion between the wheel and the rail remains practically constant, regardless of the speed.

At high speeds a greater brake cylinder pressure with a corresponding increase in brake-shoe pressure can be used without danger of sliding wheels; but in such cases it is also necessary to provide a means for reducing the high cylinder pressure, as the speed of the train is decreased. This is accomplished by means of the automatic reducing valve shown in vertical cross section in Fig. 22. A horizontal cross section of this valve, through the point at which the connecting pipe to the brake cylinder is secured, is shown in Fig. 23. Fig. 24 shows the application of the valve to a car. Figs. 25, 26 and 27 are vertical cross sections of the upper part of the valve, showing the various positions of the slide-valve.

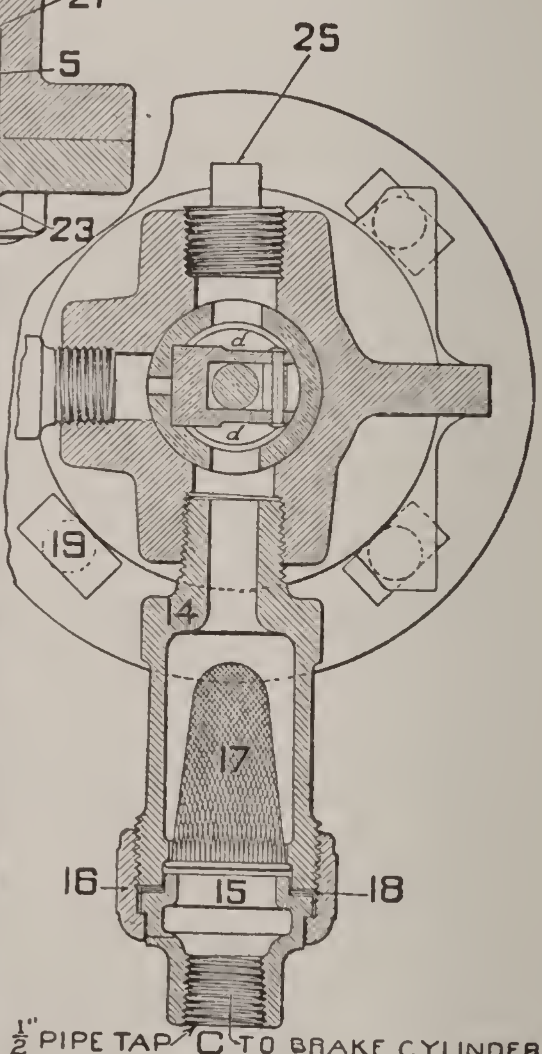
THE HIGH SPEED BRAKE REDUCING VALVE.

Operation. When air enters the brake cylinder from the auxiliary reservoir it has free access to the reducing valve through a pipe connected at C (Fig. 23), so that chamber *d*, above piston 4 is always subject to brake cylinder pressure. Regulating spring 11, which is adjusted by means of nut 12, provides a resistance to the downward movement of piston 4, which is finally



10
2
1/2" PIPE TAP
24
a
b
8
9
2
d
21
EX
e
20
EXHAUST
4
6
5
c
3
22
23
7
11
12
13

Fig. 22.



25
d
d
19
14
17
16
15
18
1/2" PIPE TAP
C
TO BRAKE CYLINDER

Fig. 23.

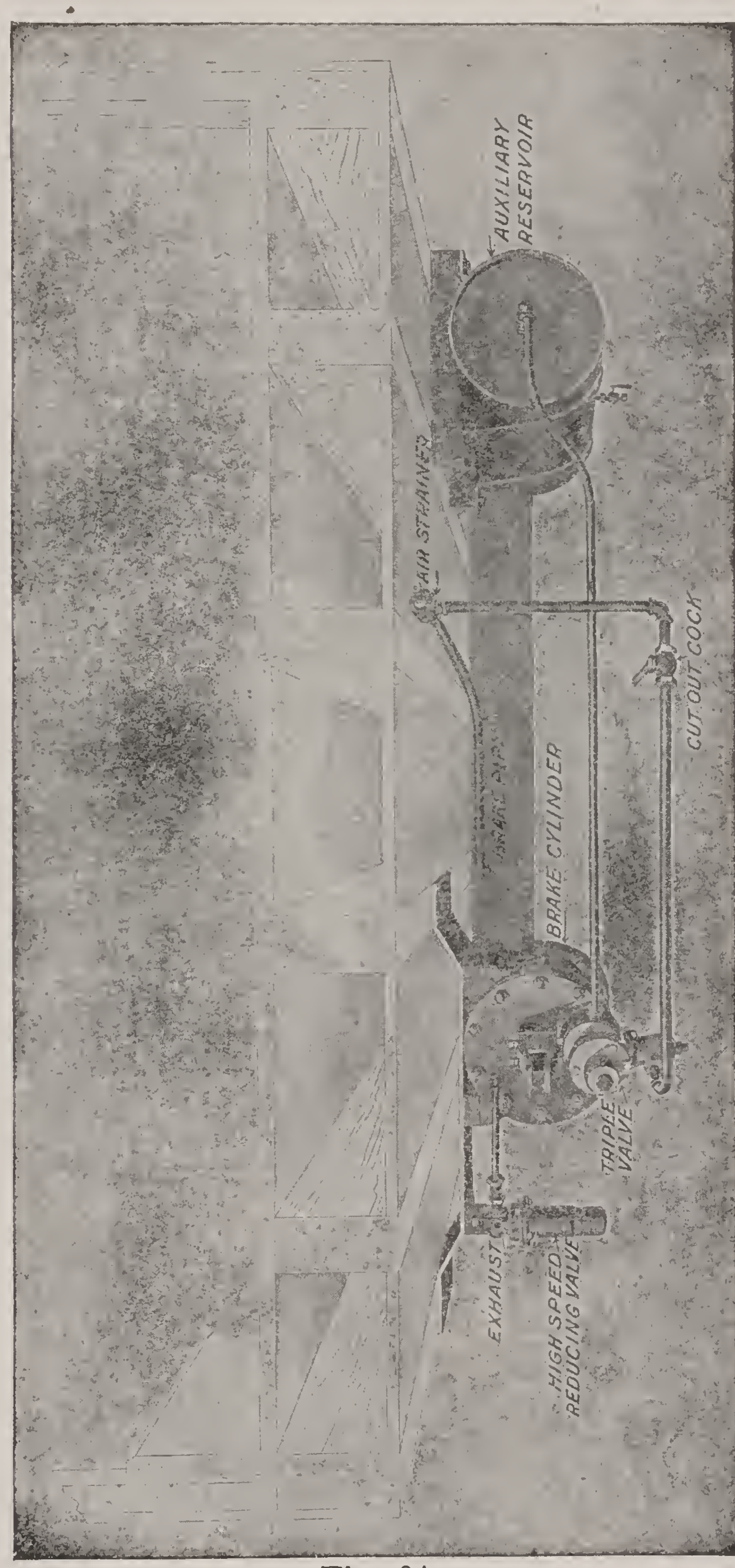

AUXILIARY RESERVOIR
AIR STRAINER
CUT OUT COCK
BRAKE CYLINDER
TRIPLE VALVE
EXHAUST
HIGH SPEED REDUCING VALVE

Fig. 24.

arrested by spring-box 3. Combined with piston 4 is its stem 6, fitted with two collars, which control the movement of the slide-valve 8. Slide-valve 8 is provided with a triangular port *b* in its face, which is always in com-

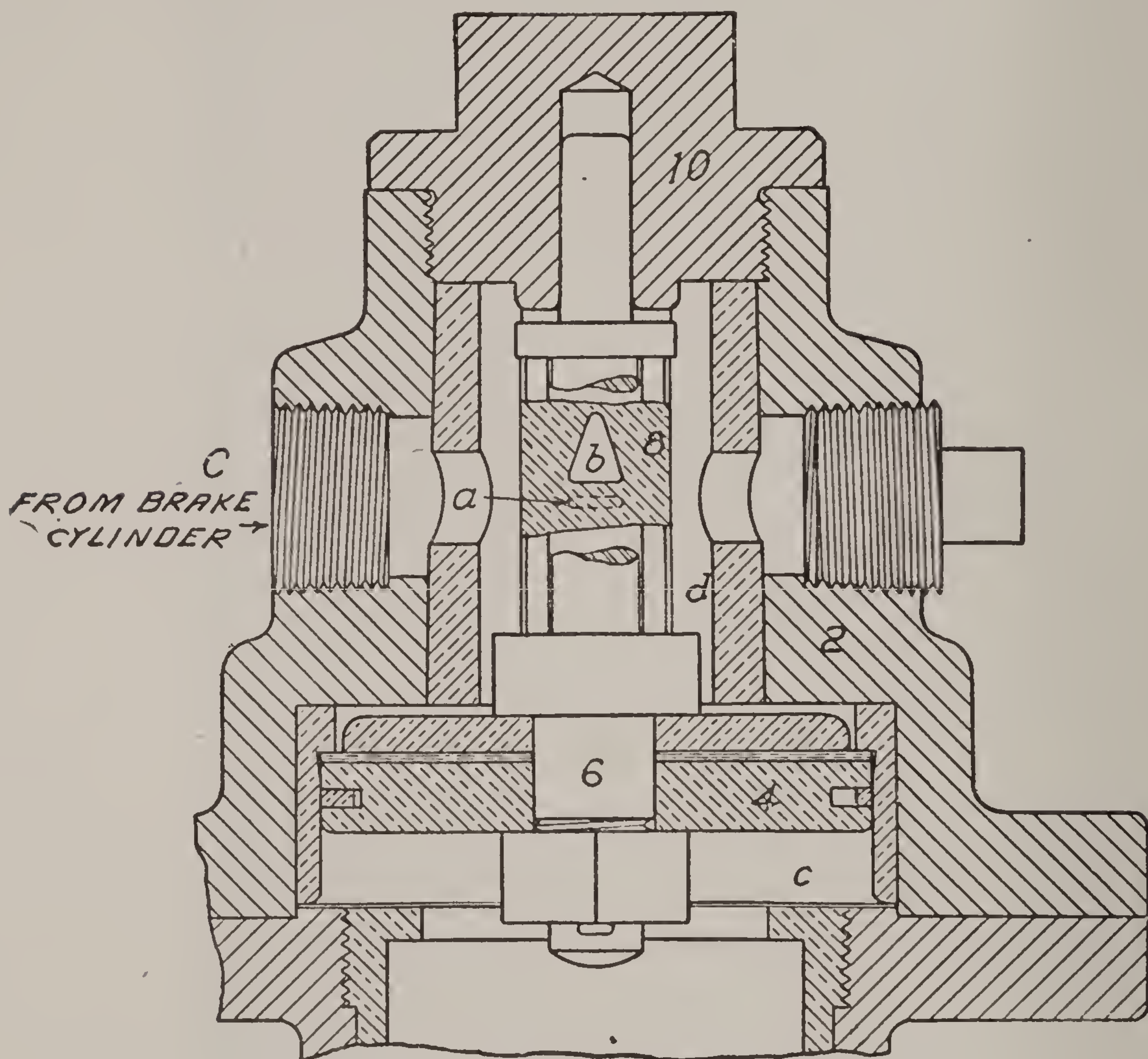


Fig. 25.

munication with chamber *d*. Port *a* in the slide-valve seat leads directly to the atmosphere through exhaust opening EX.

Slide-valve 6 and its piston 4 are shown in their normal positions in Fig. 25.

It will be noted that in release position port *b* of slide-

valve 8 does not register with port *a* of its seat, so that when the brakes are applied the air pressure is retained in the brake cylinder and is subsequently released in the usual way, unless it becomes sufficiently high to overcome the tension of spring 11 and force piston 4 downward.

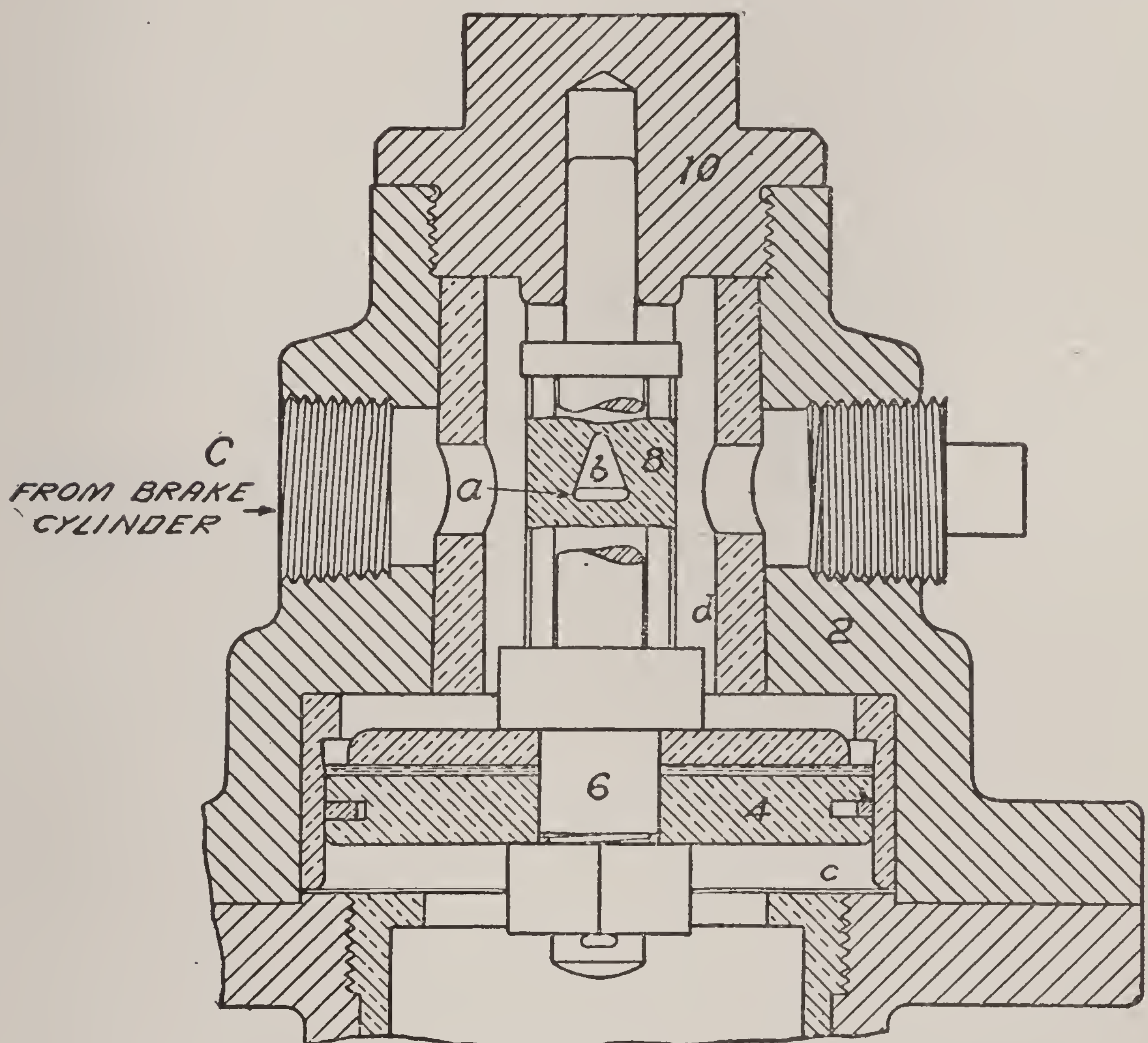


Fig. 26.

Service Application. When a heavy service application is made and the brake cylinder pressure exceeds sixty pounds, the pressure upon piston 4 moves it downward until port *b* in the slide-valve registers with port *a*

in its seat (Fig. 26), in which position any surplus brake cylinder pressure is promptly vented to the atmosphere. Spring 11 then raises the piston and the slide-valve to their normal positions closing the exhaust port and retaining sixty pounds pressure in the brake cylinder. In the operation just described, the greatest width of port *b* is exposed to port *a*, and these ports are so proportioned that, in this particular position, the surplus air is discharged from the brake cylinder as rapidly as it is admitted through the service application port of the triple valve.

Emergency Application. The positions assumed by piston 4 and slide-valve 8 in an emergency application of the brakes are shown in Fig. 27. The violent admission of air into the brake cylinder suddenly increases the pressure on piston 4, forcing it to the lower end of its stroke, in which position the apex of triangular port *b* in the slide-valve is brought into register with port *a* and a comparatively slow discharge of brake cylinder pressure takes place while the train is at its highest speed; but the area of the opening of port *b* gradually increases as the decreasing pressure above piston 4 permits spring 11 to slowly raise the piston and slide-valve. The rate of discharge thus increases as the speed of the train decreases. When the brake cylinder pressure has become reduced to sixty pounds, port *a* is closed, and the remainder of the brake cylinder pressure is retained until it is released in the usual way through the triple.

When an emergency application of the brakes is made at high speeds, there is little danger of wheel sliding, and it will be observed that port *b* is so shaped that the brake cylinder pressure escapes slowly, while at lower speeds, where a heavy service application is more likely

to occur, and there is a greater tendency toward wheel sliding, the base of triangular port *b* is exposed, allowing the brake cylinder pressure to reduce quickly.

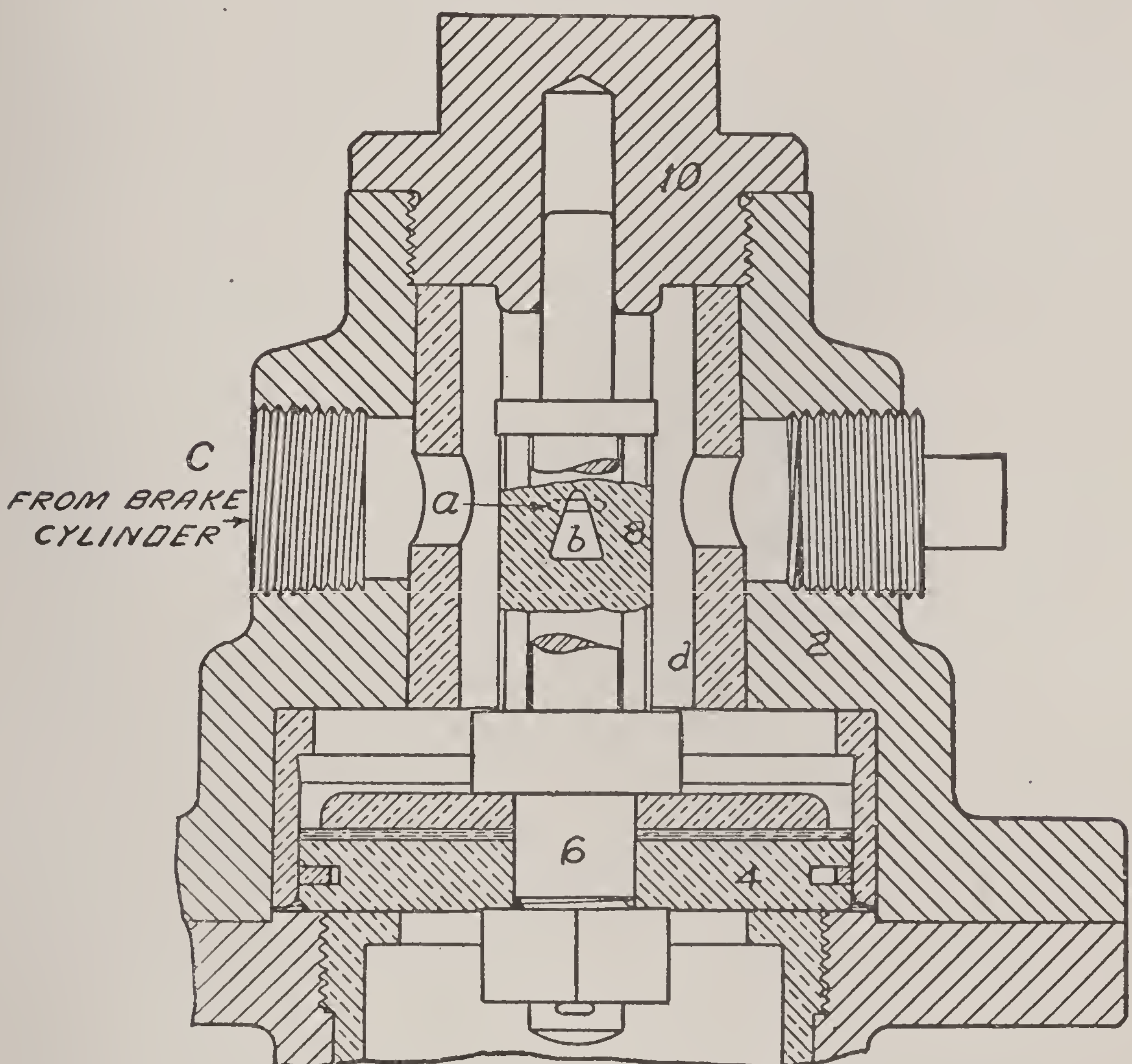


Fig. 27.

Brake Cylinder Pressure. With an emergency application, the auxiliary reservoir and brake cylinder pressures will momentarily equalize at eighty-eight pounds, and a comparatively slow discharge of brake cylinder pressure will take place while the train is at its high speed.

The high speed reducing valve is so constructed that

when piston 4 moves to its full stroke it is arrested by shoulder 3, thus permitting the valve to be constantly open from the brake cylinder to the atmosphere while the piston and slide valve are in a downward position.

Inspection. Reducing valves should be inspected occasionally, to prevent possible leakage through the discharge port and to ascertain that the valve closes at the proper pressure.

Cars Not Equipped With Reducing Valves. Cars not equipped with the reducing valve should not be attached to trains employing the high speed brake, unless the brake cylinders are equipped with a safety valve provided for temporary use in such cases. The safety valve will prevent a pressure greater than standard pressure in the brake cylinders of the cars not equipped with reducing valves. The safety valve may be quickly screwed into the oil hole of the brake cylinder head, and removed when the cars are again placed in ordinary service.

Standard Pressure For High Speed Service. The standard pressures for high speed service are, one hundred and ten pounds brake pipe, and one hundred and thirty pounds main reservoir pressure.

Advantages of High Speed Pressure in Service Applications. With the high speed brake two full service applications and releases can be made without any effort to recharge, and still have seventy pounds of air in the auxiliary reservoir with which to stop.

DEFECTS OF THE HIGH SPEED REDUCING VALVE.

A failure of the brakes to remain set may be caused by a cut slide-valve or seat; a broken or improperly ad-

justed regulating spring; packing ring 5 or packing leather 20 defective; or a leak in the pipe connection leading from the brake cylinder to the reducing valve.

GENERAL INFORMATION RELATING TO THE HIGH SPEED BRAKE.

When using the high speed brake it should be remembered that with a brake pipe pressure of one hundred and ten pounds and the usual piston travel a service brake pipe reduction of five, ten or fifteen pounds will develop no more cylinder pressure than if the usual seventy pound brake pipe pressure were employed. If, however, when using a pressure of one hundred and ten pounds, the reduction is continud after the cylinder pressure has reached that at which the auxiliary reservoir and brake cylinder pressures equalize with the seventy pound brake pipe pressure, the cylinder pressure will increase until relieved by the reducing valve.

If the brake-valve is placed in service position and allowed to remain there, the reducing valve, when it opens, will reduce the cylinder pressure about as fast as the triple valve can feed the air from the auxiliary reservoir to the brake cylinder. While the habit of making more than twenty or twenty-five pound service reduction is not good practice, the feature just described goes to show that with a service reduction the cylinder pressure will not rise materially above that at which the reducing valve is adjusted, which practically eliminates any possibility of wheel sliding under ordinary conditins.

The high speed brake was designed primarily to provide a means of stopping fast trains within a reasonable and safe distance, but it can also be used advantageously to save time in making service stops on local trains. To accomplish this result, when the speed of the train exceeds thirty miles per hour, a heavy initial reduction of from twelve to fifteen pounds should be made, and when the speed of the train is reduced to from fifteen to eighteen miles per hour, a release should be made to exhaust the high cylinder pressure and allow the truck to regain their equilibrium. A light reduction will then stop the train without any attendant disagreeable shock. This method of using the air is not only productive of quick stops, but it reduces the liability of wheel sliding to a minimum, as the low cylinder pressure coincident with slow speed.

THE NEW YORK QUICK ACTION TRIPLE VALVE.

This triple valve is called a quick action triple for the reason that when an emergency application is made it carries auxiliary reservoir air to the brake cylinder almost instantly, equalizing the pressure through the large opening, past the quick action valve augmented to some extent through the service opening past the graduating valve, and, by reason of venting brake pipe air to the atmosphere, it produces a quick serial action of all other quick action triples throughout the train.

When a service application is made, air passes slowly from the auxiliary reservoir to the brake cylinder, through the graduating service port only, and there is no local venting of brake pipe air.

The quick action triple valve, as shown respectively in release, service, lap and emergency positions in Figs. 28, 29, 30 and 31, is used on freight cars. Port F of this triple valve is drilled through the stem, the same as it is on the new passenger triple.

List of Parts. The parts of the quick action triple valve shown in Figs. 28 to 33 inclusive, are as follows:

QT 3. Packing Ring.
QT 9. Exhaust Valve.
QT 20. Rubber Seating on Valve QT 71.
QT 28. Triple Strainer.
QT 32. Drainage Plug.
QT 38. Exhaust Valve.
QT 45. Packing Ring in Piston QT 129.
QT 48. Graduating Valve.
QT 49. Graduating Spring
QT 71. Vent Valve.
QT 117. Non-Return Check.

QT 128. Triple Piston, having an extension which forms a cylinder in which Vent Valve Piston QT 129 operates.

QT 126. Triple Head or Cap.

QT 130. Middle Section of Flange and Seal for Vent Valve.

QT 132. Vent Valve Spring.

QT 133. Leather Gasket.

QT 134. Rubber Gasket.

QT 135. Cap, Bolt.

QT 136. Emergency Cap Bolt.

QT 137. Quick Action Piston.

QT 138. Quick Action Valve.

QT 140. Quick Action Valve Spring.

QT 141. Quick Action Valve Cap Nut.

QT 142. Stop for piston on QT 129.

Ports and Passages. Small port F, drilled through piston stem QT 129, is to supply air from the brake pipe to chamber G, between pistons QT 128 and QT 129; passage K in the body of the triple valve is for the purpose of allowing air from the auxiliary reservoir to pass to the emergency valve QT 138; LL is a passage in the body of the triple valve between valves QT 138 and QT 117, and is for the purpose of venting air from the auxiliary reservoir to the brake cylinder when the emergency brakes are used; QT 125 is the lower portion of the triple valve body, known as the drainage, and where the pipe connection is made at triple valve W; H is a passage leading from vent valve QT 71 to quick action piston QT 137 and to the atmosphere at J. The feed groove in the triple valve body cylinder is at B.

Course of Air. Fig. 28 shows the course of the air

(indicated by arrows) from the time it enters the triple valve until it enters the auxiliary reservoir. Air enters the strainer at W, passes through passage A

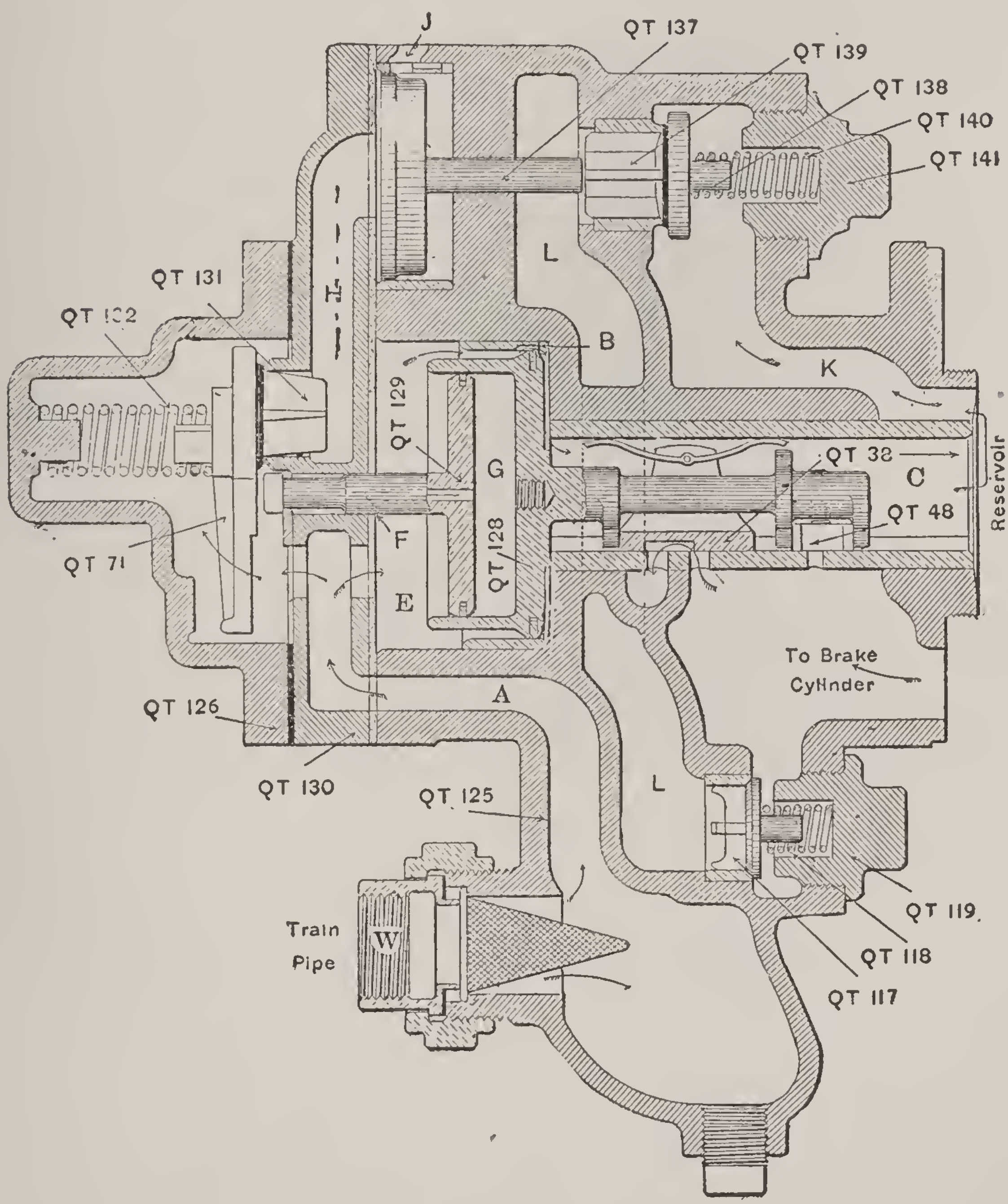


Fig. 28.

Release and Charging Position.

into chamber E, past piston QT 128, through feed groove B, and thence to the auxiliary reservoir at C,

until the brake pipe and auxiliary reservoir pressures are equalized.

Operative Parts. Fig. 29 shows the following principal operative parts of the New York quick action triple valve in service application; QT 128, Main Triple Piston; QT 38, Exhaust Slide Valve; QT 48, Graduating Slide Valve; QT 129, Vent Piston.

Main piston QT 128 has the same movement for service and emergency applications and is extended to form a cylinder in which vent piston QT 129 is fitted. A small port and passage F is drilled through the stem of piston QT 129, which allows brake pipe air to pass into chamber G, formed between the vent valve piston and the main triple piston, equalizing the pressures on both sides of the vent piston.

Service Application. When a service reduction of brake pipe air is made, reducing the pressure in chamber E, the auxiliary reservoir pressure being the greater forces piston QT 128 toward the weaker pressure, closing feed groove B. Port F is made of such size that when main piston QT 128 moves slowly to the left in a service application, as shown in Fig. 29, thereby reducing the size of chamber G, the air in chamber G will pass through port F to the brake pipe, without moving piston QT 129 from its normal position. In a service application the triple piston moves over only a portion of its stroke, bringing the small service port in the slide valve QT 48 opposite the port in its seat leading to the brake cylinder, the quantity of air admitted being in proportion to the brake pipe reduction. If the brake pipe pressure is reduced but little, the pressure in the auxiliary is reduced by expansion into the brake cylinder to slightly less than

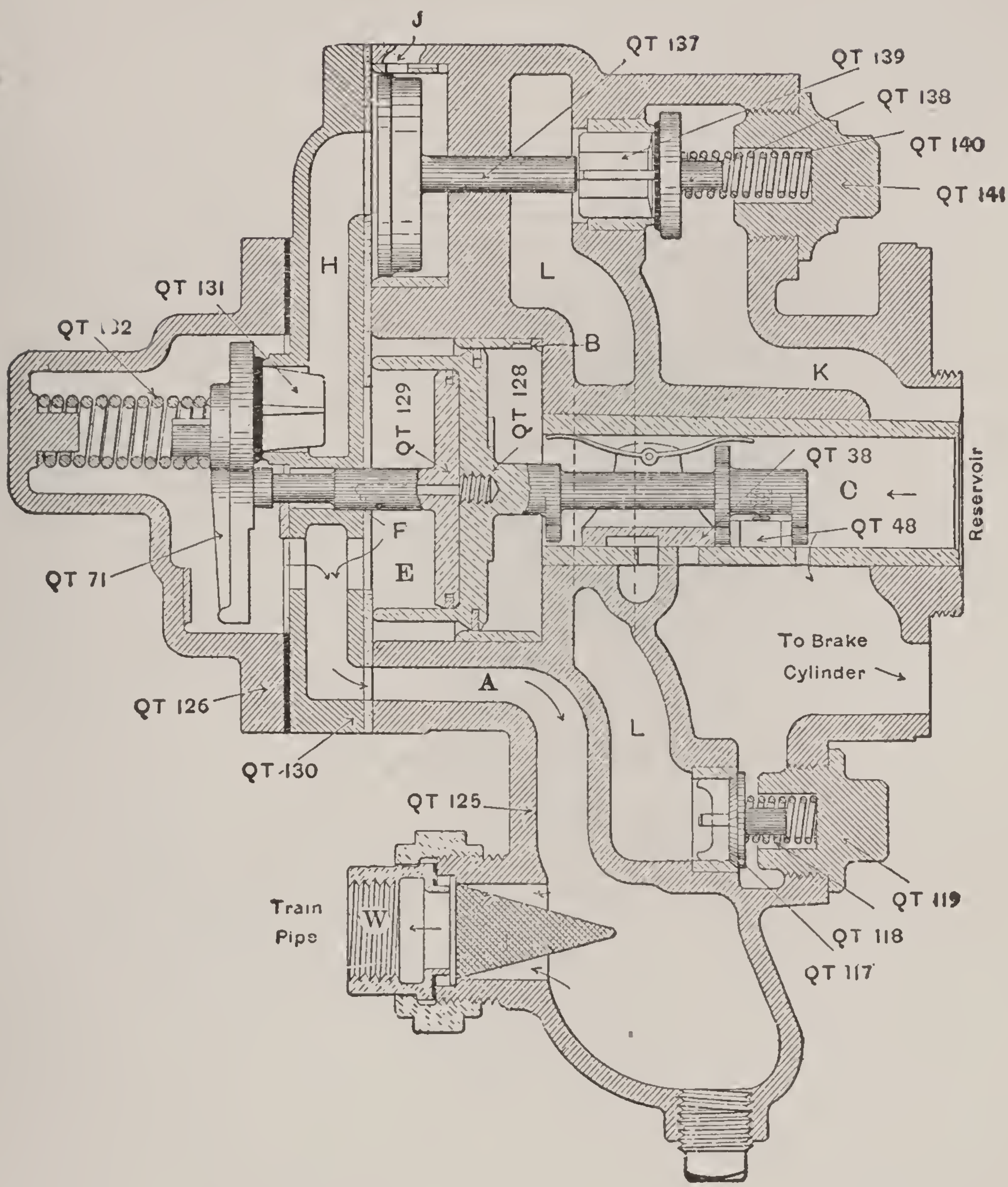


Fig. 29.

Service Position.

that in the brake pipe. When piston QT 128 starts back and carries graduating valve QT 48 to lap position, as shown in Fig. 30, it closes the service port without disturbing exhaust valve QT 38, thus closing

communication between the auxiliary reservoir and the brake cylinder.

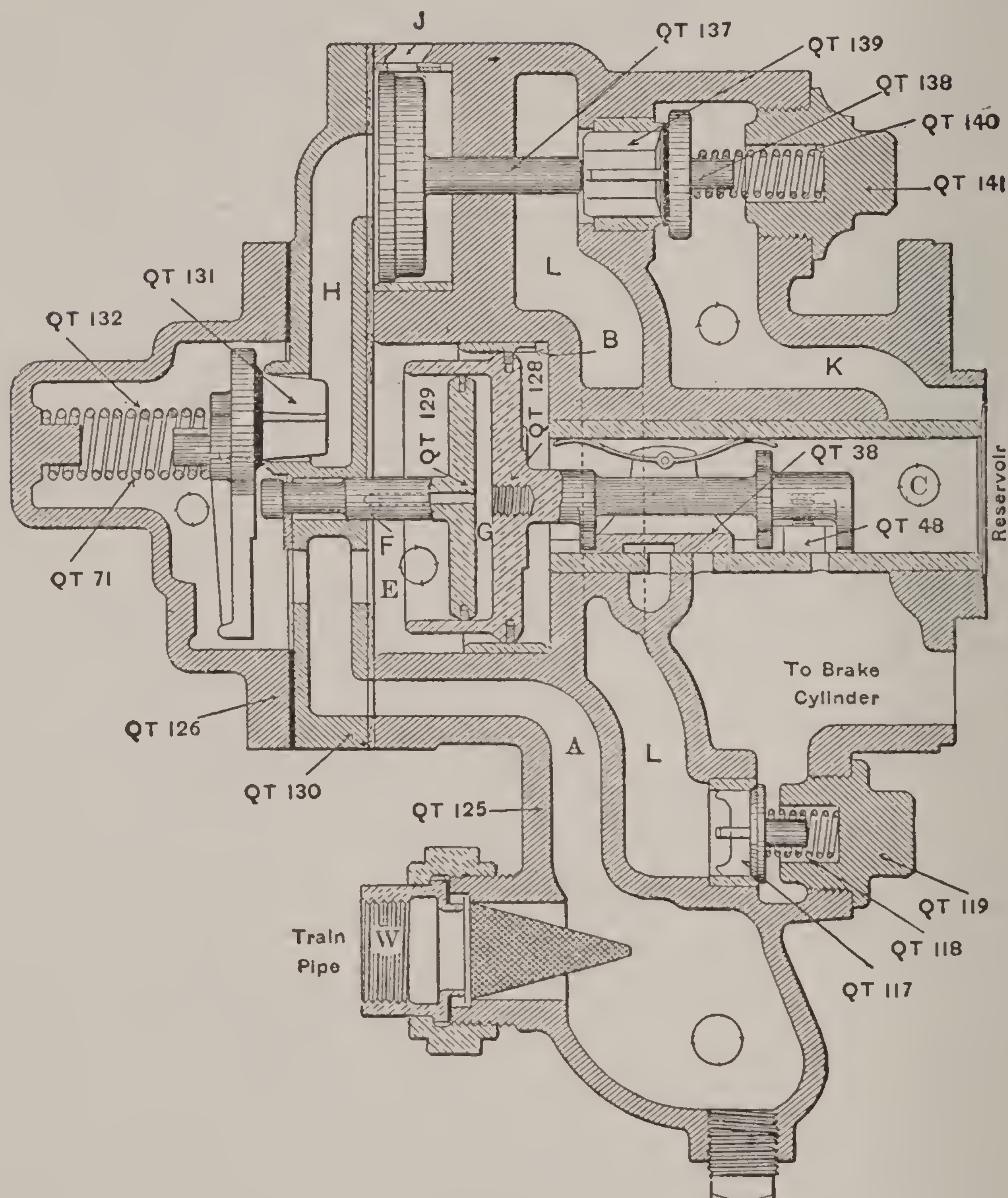


Fig. 30.

Lap Position.

The plain triple valve has the triple piston, the exhaust valve and the graduating valve. The additional valves described in the list of parts are for use in emer-

gency applications for the purpose of allowing the triple valve to vent the brake pipe air to the atmosphere, and at the same time cause quick equalization of the auxiliary reservoir and brake cylinder pressures.

The additional parts of the quick action triple valve brought into use when an emergency application is made are, Vent Valve Piston QT 129, Vent Valve QT 131, Quick Action Piston QT 137, and Quick Action Valve QT 138.

In service applications these parts remain inoperative, but in an emergency application they are carried into action. Vent Valve QT 131 is held to its seat by spring QT 132, assisted by brake pipe pressure, and is opened by piston QT 129. When the piston is forced to the left, quick action valve QT 138 is held to its seat by spring 140, assisted by auxiliary reservoir pressure, and it can only be opened when quick action piston QT 137 moves to the right.

Emergency Application. In an emergency application a quick reduction is made in the brake pipe pressure, and main piston QT 128 moves quickly to the left. The air from chamber G cannot flow through port F fast enough to reduce the pressure at the same rate it is being reduced in the brake pipe, and a momentary excess pressure taken place in chamber G sufficient to force piston QT 129 to the left, which in turn forces vent valve QT 131 from its seat. The vent valve being off its seat, brake pipe air enters passage H and escapes to the atmosphere through port J, but before the air escapes through port J it exerts a strong pressure upon quick action piston QT 137, forcing it to the right and causing it to unseat quick action

valve QT 138. This allows the auxiliary reservoir air to flow rapidly through the large passage K, past the non-return check valve QT 117, and to flow through passage L to the brake cylinder, shown in Fig 31.

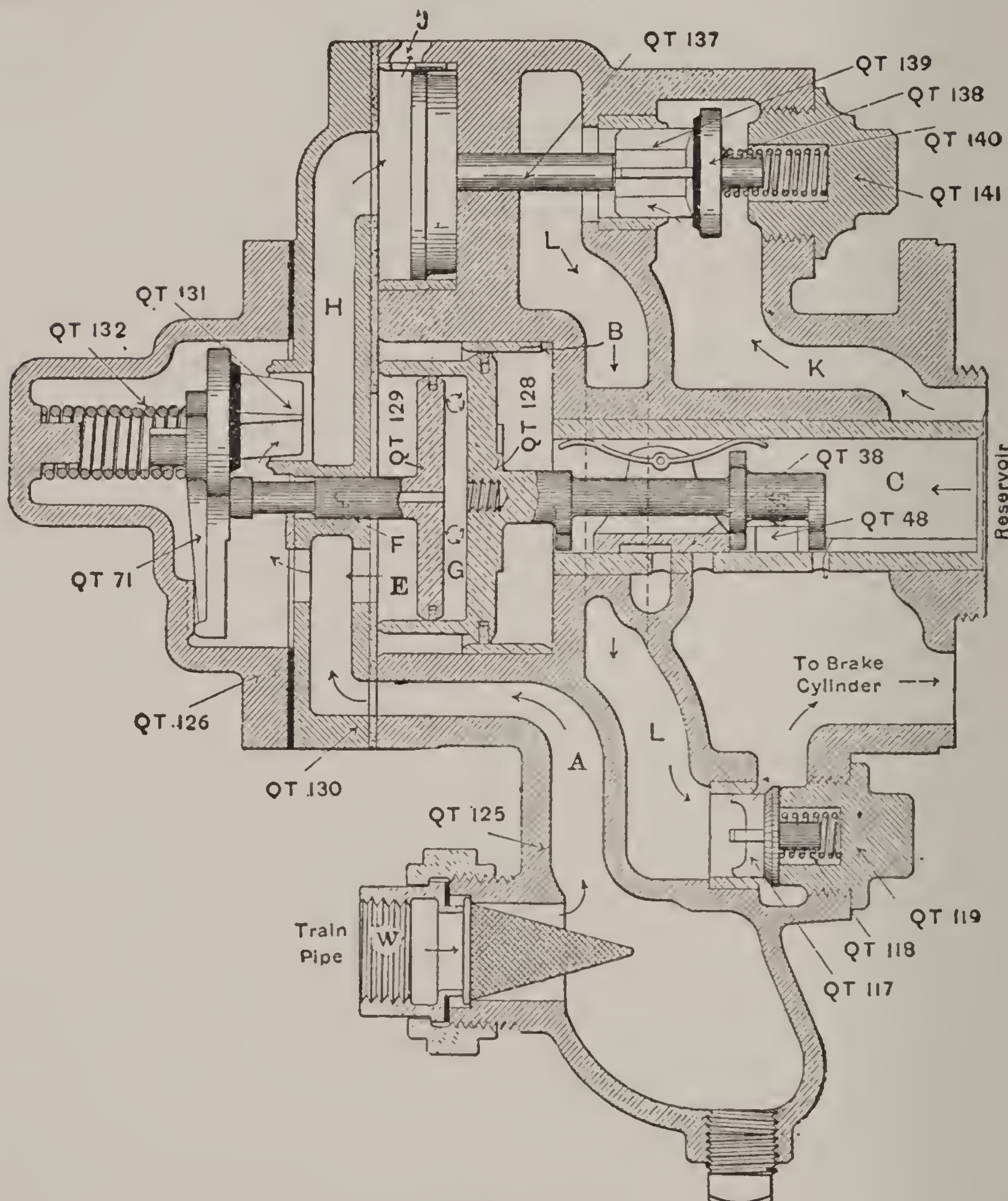


Fig. 31.
Emergency Position.

Releasing. The brakes are released by restoring the brake pipe pressure until it exceeds that in the

auxiliary reservoir, causing main piston QT 128, exhaust valve QT 38, and graduating valve QT 48 to return to their normal positions (Fig. 28), closing the service port, allowing the auxiliary reservoir to charge through feed groove B, and at the same time allows the air in the brake cylinder to escape to the atmosphere through the exhaust cavity of exhaust valve QT 38 and the exhaust port in its seat.

Brake Cylinder Pressure. In a service application the quick action triple valve allows the auxiliary reservoir pressure to pass to the brake cylinder gradually, as required to produce the necessary braking force, while in an emergency application it allows the full auxiliary reservoir pressure to pass almost instantly into the brake cylinder, applying the brakes with full force, and at the same time it vents sufficient brake pipe air to the atmosphere to produce a quick reduction in brake pipe pressure, which causes the following quick action triple valve to operate in quick action, and so on throughout the train, producing a quick serial action of all the brakes.

No greater pressure is produced in the brake cylinder in an emergency than in a service application, as the triple valve uses auxiliary reservoir air in both applications.

Partial Service Application. After a partial service application, an emergency application can be made, but the quick action parts will not operate in a mnner so as to produce a quick operation of all the brakes and an instantaneous equalization of pressure in the brake cylinder. However, if an emergency arises after a service application has been made, and the brake valve is placed in emergency position, allowing the brake

pipe pressure to escape freely to the atmosphere, all the brakes on the train will apply with their full braking power much more quickly than if a service reduction were made. The operation of the quick action triple can be obtained only when the pistons are separated with chamber G at its normal size.

Auxiliary Pressure. As auxiliary reservoir pressure alone goes to the brake cylinder in both service and emergency applications, it might be considered that both applications will be equally effective. This is not the case, however, for the service application is slower than the emergency, and for this reason a full emergency application is much more effective than a full service application. When a partial reduction is made, followed by an emergency reduction, the comparative effectiveness depends on how heavy the service application is before the emergency application is made, and also upon the length of the train. However, when a service application is begun, and is then followed by an emergency application, the effectiveness of the brakes will not be as great as if an emergency reduction had been made at first.

Cars Cut Out. Two or three cars with brakes cut out placed together in a train will not prevent the quick action triple valves on the following cars from operating quick action. The number of cut-out triple valves that can be placed together in a train without interference of this kind depends largely on their location in the train, varying from three, placed together behind the first quick action triple valve, to six or eight, placed close to the rear of a fifty car train.

Vent Valve. Vent valve QT 131 will not remain open and exhaust all the brake pipe air to the atmos-

phere when an emergency application is made. Port F is always open, and the moment chamber G excess pressure is exerted on piston QT 129 it quickly equalizes with brake pipe pressure, and spring QT 132, together with brake pipe pressure, will return valve QT 131 to its seat, thus stopping the escape of air when the brake pipe pressure is reduced sufficiently to apply the brakes with full force. As valve QT 131 closes, piston QT 129 returns to its normal position, its travel in that direction being limited by stop QT 142. Valve QT 138 and piston QT 137 will return to their normal positions after equalization has taken place in the brake cylinder.

PASSENGER QUICK ACTION STYLE "S" TRIPLE VALVE.

List of Parts. The names of the parts of this new style of valve as shown in Figs. 32 and 33, are as follows:

QT 9. Exhaust Valve Spring.
QT. 20. Rubber Seat on Valve QT 71.
QT 28. Strainer.
QT 32. Drainage Cap Plug.
QT 45. Packing Ring on Piston QT 164S.
QT 49. Graduating Valve Spring.
QT 71. Vent Valve.
QT 117. Non-Return Check.
QT 118. Non-Return Check Valve Spring.
QT 119. Non-Return Check Cap.
QT 126. Triple Head or Cap.
QT 130. Middle section of Flange and Seat for Vent Valve QT 131.

QT 132. Vent Valve Spring.
QT 133. Leather Gasket.
QT 134. Rubber Gasket.
QT 135. Cap Bolt.
Valve Spring.
QT 141. Quick Action Valve Cap.
QT 142. Stop for Piston QT 166S.
QT 137. Quick Action Piston.
QT 138. Quick Action Valve.
QT 140. Quick Action
QT 162S. Exhaust Valve.
QT 163. Graduating Valve.
QT 166S. Triple Piston (including Packing Ring QT 3).

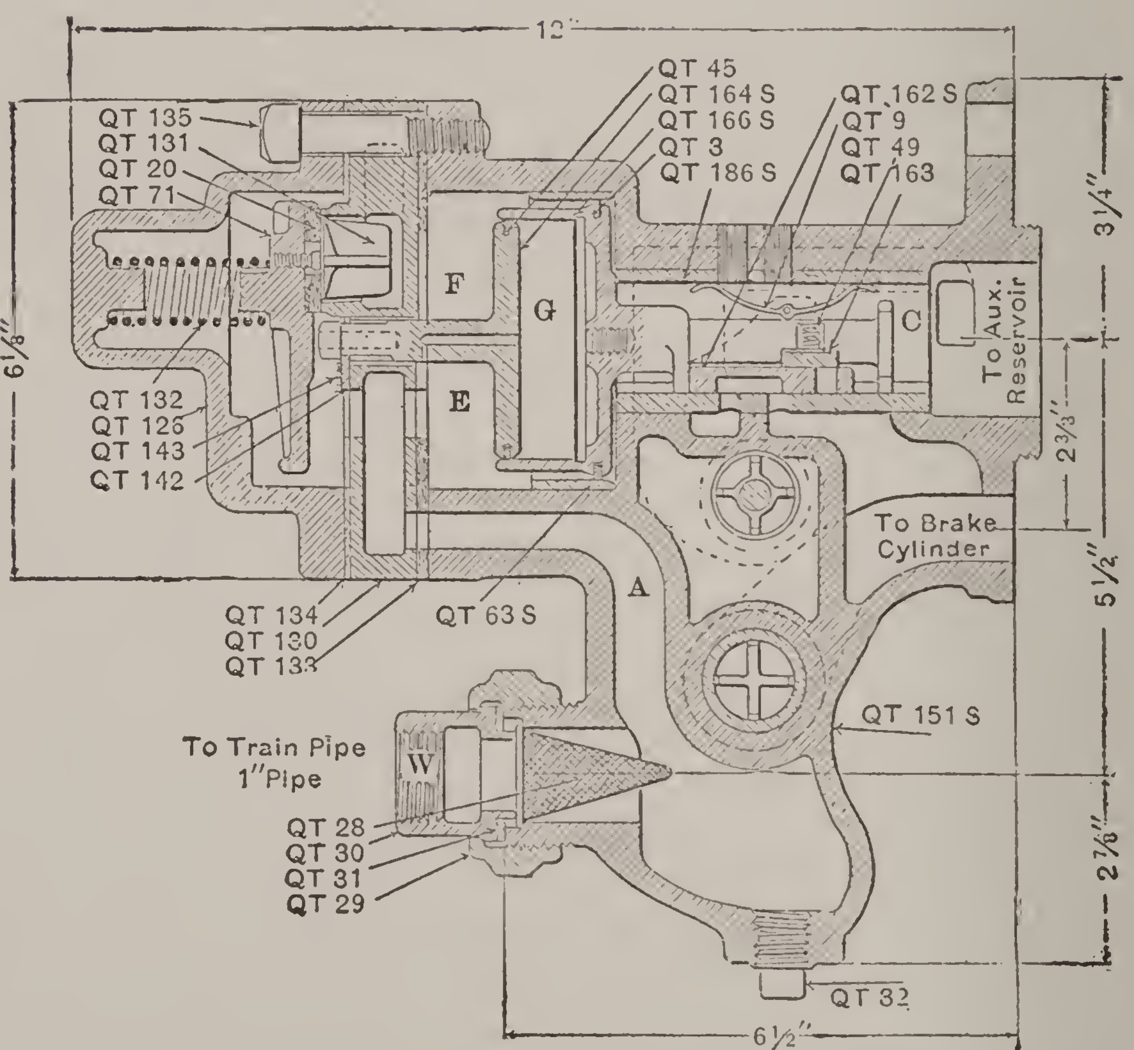


Fig. 32.

Small port F is drilled through the piston stem for the purpose of supplying air from the brake pipe to chamber G between QT 166S; QT 164S; passage K in the triple valve body is for the purpose of allowing air from the auxiliary reservoir to pass to emergency

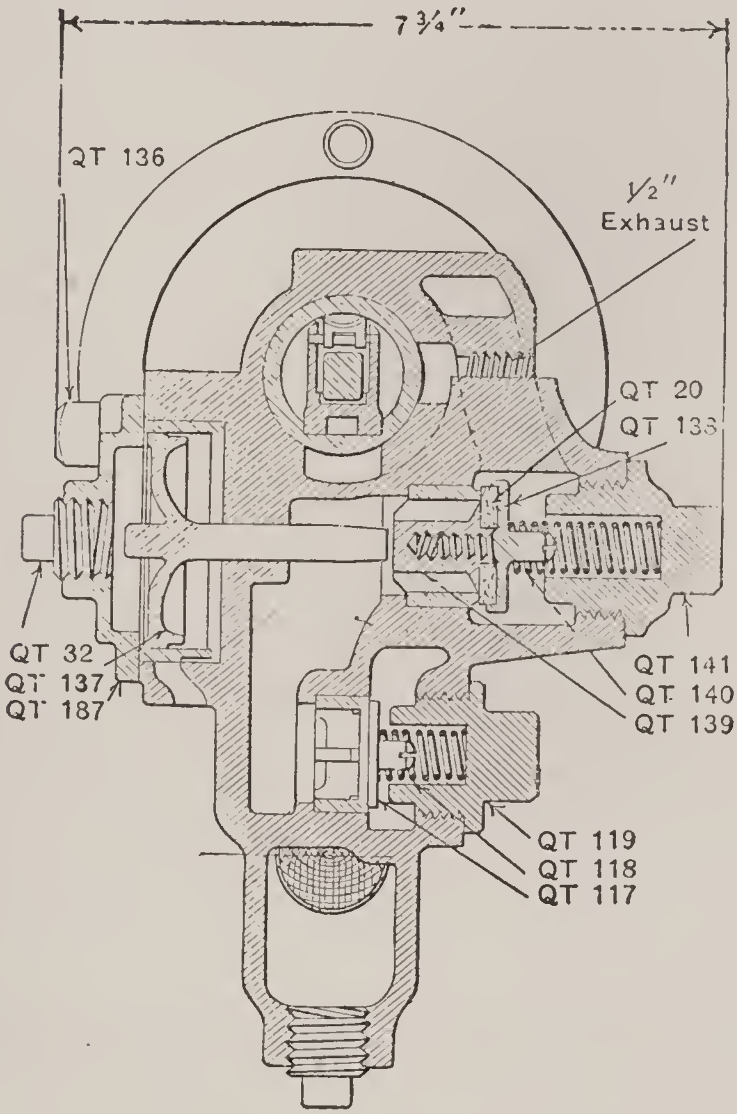


Fig. 33.

valve QT 138; L, L is a passage in the body of the triple valve between valves QT 138 and QT 117; QT 125 is the lower portion of the triple valve body known as the drainage, and provides for the brake pipe connection at W.

Graduating Valve and Ports. This style of valve used on 12, 14 and 16 inch brake cylinders is larger than the ordinary quick action triple valve; it has a large graduating port for the air to pass through to the brake cylinder; it also has a larger exhaust port and exhaust valve QT 162S and has the graduating valve QT 163 mounted on top of exhaust valve QT 162S (Fig. 32).

Friction. The friction of the operative parts is reduced by placing the graduating valve on top of the exhaust valve. When triple piston QT 166S begins to move, the graduating valve moves first to uncover the service ports in exhaust valve 162S; then the exhaust valve is moved until the graduating ports in the exhaust and its seat come in register. In this style of triple valve, but one slide valve is moved at a time.

Different Types. This style of triple valve can easily be distinguished from the freight and 10 in. passenger triples, as the letter "S" is cast on the body of the valve and the triple is fastened to the brake cylinder with three studs. The letter "S" is also stamped or cast on all parts of this valve that are not interchangeable with those of the other valves mentioned.

DEFECTS OF THE NEW YORK QUICK ACTION TRIPLE VALVE.

If the graduating valve QT 163 in the style "S" triple valve leaks it can be detected by making a partial service reduction, and then noting whether the brake released of its own accord. A leak of this kind will not allow the auxiliary pressure to escape through the exhaust port while exhaust valve QT

162S is in release position, for in this position it closes the opening from the auxiliary reservoir to the brake cylinder and atmosphere, and air leaking by the graduating valve QT 163 cannot escape.

Cap Nut. If cap nut QT 141 is not securely fastened or the emergency valve leaks it will allow auxiliary pressure to leak away the same as a slightly open release valve. If the amount of leakage is large it will cause the brake to release.

Leaky Check Valve. If the check valve leaks or cap nut 119 is not securely tightened it will allow all brake cylinder air to leak away, reducing the braking power, the same as with a leaky piston packing leather.

Blow at Port J. A constant blow of air from port J in the side of the triple valve indicates that the vent valve is leaking. If accompanied by a blow at the triple exhaust port it indicates that the emergency valve is leaking. If the vent valve leaks it will cause an application of the brake when the cut-out cock in the cross-over pipe is closed; but if the emergency valve leaks the brake will not apply with the closing of the cut-out cock.

Maintaining Pressure. If it is difficult to maintain normal brake pipe pressure and the brakes will not release properly it indicates a bad leak in the brake pipe. The hose and brake pipe connections should be carefully examined and it should be noted whether there is a blow at port J of the triple valve; if so, the leakage will be coming direct from the brake pipe, due to vent valve QT 131 not being seated properly, or the rubber seat being defective.

Brake Applying in Quick Action. If a brake applies in quick action when a service reduction is made

it may be due to the packing rings in vent piston QT 129 fitting the cylinder too tightly, a weak vent valve spring QT 132, or small port F in vent valve piston QT 129 being stopped up.

If the brakes do not apply in quick action when the proper reduction is made the packing ring of vent valve piston QT 129 may be worn or fit poorly.

Blows at the Triple Exhaust. A blow at the triple exhaust would be due to leaky exhaust valve QT 38, leaky graduating valve QT 48, a defective gasket between the body of the triple valve and brake cylinder head with passenger equipment, a defective gasket, between the auxiliary reservoir and the triple valve with freight equipment, or a leak in the auxiliary tube leading from the triple valve to the brake cylinder.

A leaky exhaust valve would cause a blow at the exhaust port, whether the brake were applied or released, and when applied it would cause the brake to release.

Leaky Graduating Valve. A leaky graduating valve, with the triple valve in lap position, will allow the auxiliary pressure to escape under the graduating valve and through the port into the brake cylinder, reducing the auxiliary pressure and setting the brake with greater force. Whether this will allow the brake to release will depend upon whether or not the piston packing ring is tight. If the packing ring is in good condition the auxiliary reservoir pressure will continue to feed by the defective graduating valve until sufficient reduction exists between the brake pipe and the auxiliary reservoir to start the exhaust valve, when it may move to release position and release the brake. If the piston packing ring or the piston is de-

fective, and air leaks into the auxiliary reservoir as fast as it leaks by the graduating valve into the brake cylinder, the brake will continue to set instead of releasing, until the pressures are equal; therefore, under such conditions, a leaky graduating valve cannot release the brake.

Failure of Brakes to Apply. A failure of the brakes to apply on a car when a brake pipe reduction has been made may be due to the feed grooves or strainer being stopped up, preventing the auxiliary reservoir from charging, or the triple valve may be gummed or dirty, so that the piston cannot move. In this case the brake will not apply on the car with the defective triple when a service reduction is made. If a heavy reduction is made the triple may be forced loose and it will probably work satisfactorily during the remainder of the trip.

Sticky Triple Valve. A sticky triple valve is sometimes the cause of a brake applying in quick action on a car during a service brake pipe reduction. In this case the triple will not usually respond to the first and sometimes the second service reduction, and the brake on the car with the defective valve will not apply until the difference between the auxiliary reservoir and brake pipe pressure is sufficient to cause the triple piston to start from its stuck position and move forward quickly to emergency position, the stem striking sufficiently hard to compress spring QT 132 and open vent valve QT 131, thus causing quick application of the brakes on this car.

How to Locate a Defective Triple. To locate a sticky or defective triple valve, with a full brake pipe pressure, a reduction of from 5 to 10 pounds should

be made, the amount depending on the length of the train. The brake piston that has failed to move out should then be looked for, and when it is found the brake should be cut out and the test repeated in order to render it certain that the faulty triple had been located. On freight trains a sectional test should be made until the defective triple is located.

Brakes Failing to Release. If a brake fails to release and there is a strong blow at port J it may be due to vent valve QT 131 being held from its seat by dirt or scale, or a badly worn triple piston packing ring, which would allow the brake pipe pressure to feed slowly past the packing ring, charging the auxiliary reservoir, without forcing the piston to release position, and releasing the brake.

STYLE "A" NEW YORK HIGH SPEED BRAKE COMPENSATING VALVE.

The high speed reducing valve, shown in Fig. 34, is called a compensating valve, for the reason that while operating in a service application, as an ordinary safety or pressure reducing valve, in an emergency application it holds the maximum cylinder pressure for a limited time before commencing to relieve it. The period during which the pressure is held is automatically shortened or lengthened according to the variation obtained in the maximum brake cylinder pressure on the piston, or in both combined, as the valve makes allowance in the time of holding this pressure. On account of these variations the closure of all valves upon the train will be practically uniform.

List of Parts. The compensating valve consists of the following parts: HS 77, Piston Valve, which works in a Bushing or Cylinder; HS 81, Packing Rings, there being two of these, either of which may act as a valve for the relief and leakage port; HS 11, Regulating Spring, by which the piston is held in its normal position against the brake cylinder pressure; HS 12, Regulating Nut or Screw, by means of which the tension of the spring is regulated; HS 87, Non-Return Check Spring; HS 76, Spring Box; HS 10, Cap Nut; HS 83, Non-Return Check Valve with casing complete.

Emergency. In an emergency application, the air vented from the brake pipe into spring box HS 76

passes non-return check valve HS 83, which then seats and prevents the air that is entrapped in the spring box

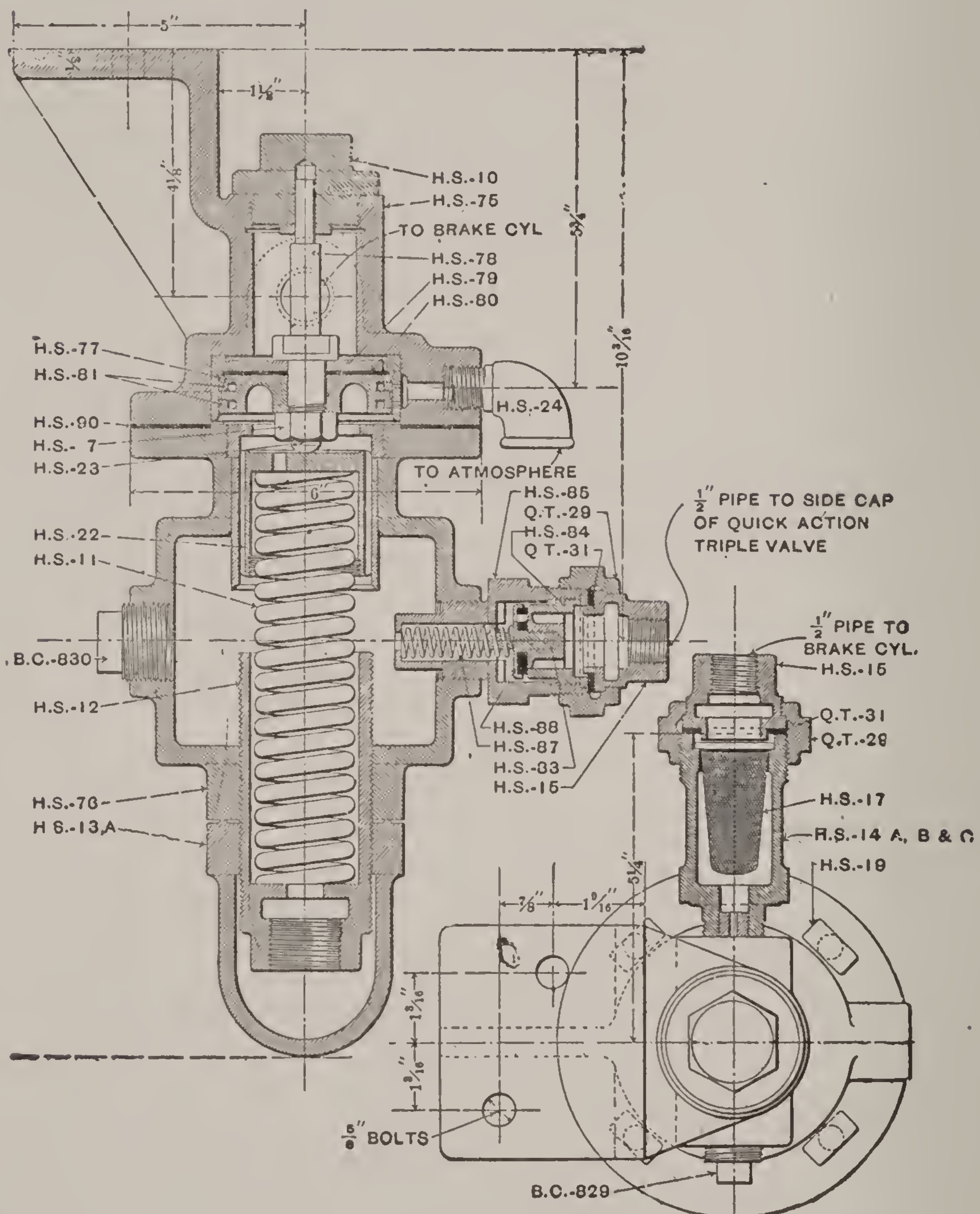


Fig. 34.

from escaping, except as it passes out slowly through the small port drilled through the check valve.

Piping. The compensating valve is connected with

the brake cylinder and the triple valve as shown in the piping diagram (Fig. 35). With the style "A"

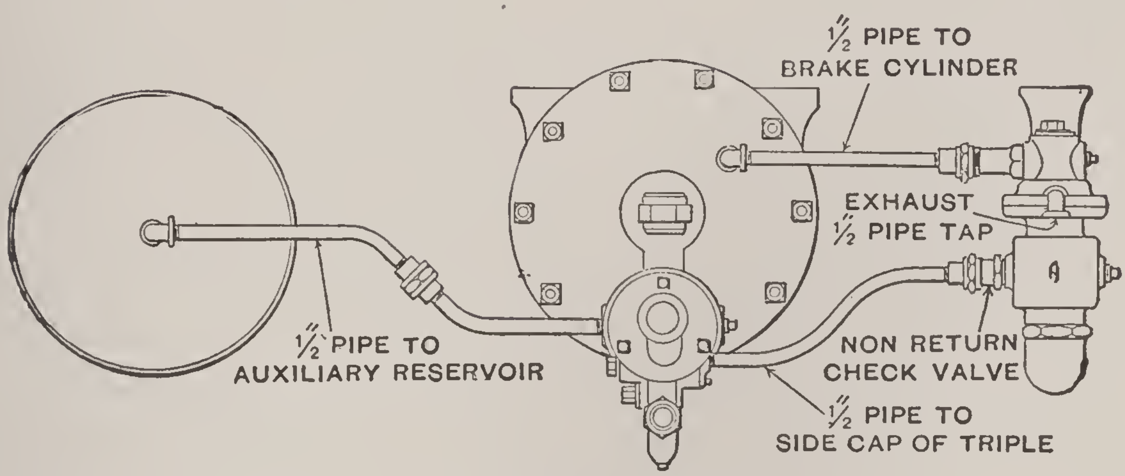


Fig. 35.

compensating valve, a one-half inch pipe connection is made from the chamber above piston HS 77 and the brake cylinder, and another pipe connection leads from the side cap of the quick action triple valve to spring box HS 76, which has direct communication with the air chamber below piston HS 77. All the pipe connections should be tight.

Operation. When style "A" compensating valve is piped as shown in Fig. 35, and an emergency application is made, a portion of the brake pipe air is vented at the side cap of the quick action triple valve and passes through the pipe leading to the non-return check valve and spring box chamber, charging the spring box chamber under the piston with air pressure. This pressure re-enforces the regulating spring pressure under the piston, and permits the full equalization from the auxiliary reservoir to be had and retained for several seconds before piston HS 77 can descend and open the relief ports. The air vented

into and entrapped in the spring box chamber requires several seconds to pass to the atmosphere through the small port in non-return check valve HS 83. When the air pressure in the spring box air chamber has been reduced sufficiently below brake cylinder pressure, the piston will be forced downward, the relief ports controlled by packing rings HS 81 will be opened, and the brake cylinder pressure will be gradually reduced to a point of adjustment of the valve.

In a service application no air is vented into the spring box chamber, and the only pressure which the piston has to overcome is that of regulating spring HS 11. Consequently, when the pressure in the brake cylinder is sufficient to overcome the tension of the regulating spring, the piston will be forced downward, promptly opening the relief ports.

Packing Rings. The purpose of piston packing ring HS 81 is to form an air tight joint in the cylinder, preventing brake cylinder pressure from leaking past the piston into the spring box chamber, and it also closes the relief port when in normal position.

The lower ports controlled by the lower packing rings are leakage ports, and their function is to carry to the atmosphere whatever pressure may leak by upper packing ring HS 81, thus preventing any leakage into the spring box chamber that would tend to balance the piston and retard the escape of air from the brake cylinder.

When piston HS 77 is in normal position lower packing ring HS 81 covers the leakage ports and prevents the spring box air from leaking by this ring to the atmosphere in emergency application. When piston HS 77 has moved to the lower end of its stroke and the leakage ports

to the upper and lower packing rings are about midway between the two rings, it is evident that any leakage by the upper packing ring will pass out through these ports.

Advantages of High Pressure. The advantage of holding the maximum cylinder pressure obtained from a pressure of 110 pounds is that an emergency application is more effective in retarding the motion of the train at high speeds. If the maximum cylinder pressure is retained until the speed of the train has been reduced, the reducing valve will vent all surplus air above that pressure for which the adjusting spring is set, thus preventing the wheels from sliding at slow speeds.

Also in service application, two or more powerful applications can be made without recharging the auxiliary reservoirs, and there will still remain sufficient pressure to make an ordinary emergency application, such as would be had from a 70 pound brake pipe pressure.

Use of Compensating Valve on Different Sizes of Cylinders. The compensating valve can be used on any size of cylinder—6, 8, 10, 12, 14 and 16 inch. The rate of reduction in brake cylinder pressure will be about the same with the 16 inch cylinder as with the 10 inch, when the compensating valve is used.

When the compensating valve is used on 10 inch and 12 inch brake cylinders, union stud HS 14A is used. The opening through this stud is reduced, or, in other words, there is a choke placed in it, which to a large degree regulates the flow of air from the brake cylinder to the compensating valve, and through the latter to the atmosphere. One size of this union stud goes with the 6 and 8 inch, another with the 10 and

12 inch, and another with the 14 and 16 inch brake cylinders. Therefore, it will be seen that a size of choke can be used with each size of brake cylinder that will give exactly the same rate of reduction. The stud is the part that must be used with the corresponding size of brake cylinder, as but one style of compensating valve is used on the different sizes of cylinders.

Adjustment. The compensating valve is usually adjusted to withstand a pressure of 60 pounds, although for driver brakes, tender brakes and such cars as are provided with standard foundation brake gear, the adjustment is sometimes varied from this.

THE NEW YORK TRAIN AIR SIGNAL SYSTEM.

SIGNAL REDUCING VALVE.

Figure 36 is a cross sectional view of the signal reducing valve; X is the main drum connection and Y is the connection to the signal line.

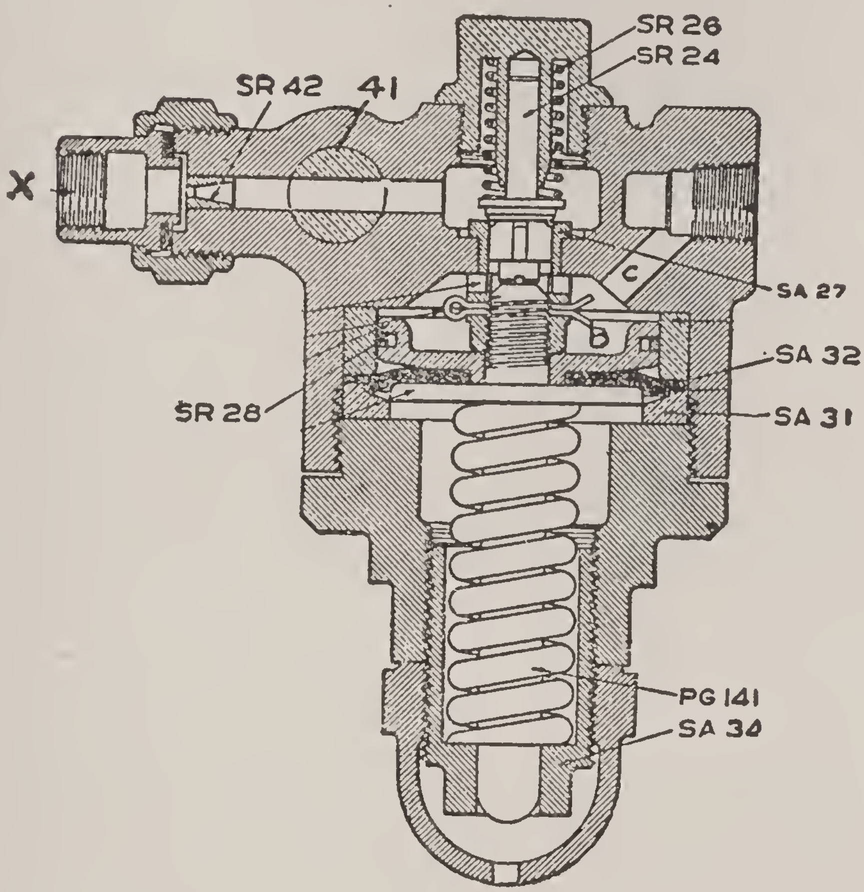


Fig. 36.

List of Operative Parts. The operative parts are as follows: SR 42, Choke; SR 41, Cut-Out Plug; SR 24, Supply Valve; SR 26, Supply Valve Spring; SR 27, Supply Valve Seat; SR 28, Piston Packing Ring; SR 29, Piston; SA 31, Diaphragm Ring; SA 32, Dia-

phragm; SA 34, Regulating Nut; PG 141, Regulating Spring.

Operation of the Reducing Valve. The main drum pressure enters at X, and regulating spring PG 141, acting on diaphragm plate SA 32, causes the stem of the plate to hold supply valve SR 24 from its seat, so that the main reservoir pressure is free to pass through the supply valve to chamber B on top of the diaphragm, and through passage C to the signal line at *y*, increasing the pressure in the signal line and chamber B until it reaches 40 pounds. When piston SR 29 is forced downward against the tension of regulating spring PG 141, supply valve SR 24 is forced to its seat by main drum pressure and supply valve spring SR 26. When a reduction is made in the signal line, the top of diaphragm SA 32 is affected. Regulating spring PG 141, forcing up on the diaphragm, unseats the supply valve SR 24, compressing supply valve spring SR 36; the main drum pressure is then free to flow by the supply valve to the signal line, charging the latter in the manner described.

THE SIGNAL VALVE.

Construction. The signal valve, as shown in Fig. 37 is generally located under the footboard of the cab. The signal pipe is connected to it at X, while a pipe leads from Y to the signal whistle. The valve body is divided into two chambers, A and B, by a rubber diaphragm SV 3, which operates diaphragm stem SV-4A. This rubber diaphragm has two disks, the lower one SV 6 of brass, and the upper one SV 12 of sheet iron, and through these disks is screwed a brass plug,

through which a hole is drilled for the passage of air. Valve SV 8 is held to its seat by gravity, and controls the passages leading to the whistle. There are three uprights AA that press against the disk or valve, and

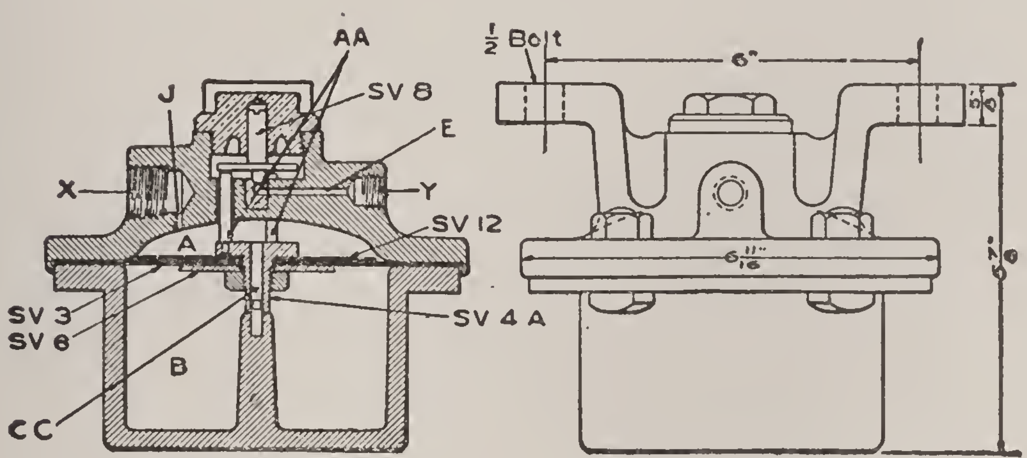


Fig. 37.

lift it from its seat whenever diaphragm SV 3 rises. The clearance between the uprights and the disk of stem SV 8 should not exceed 1-100th of an inch.

Operation. When the signal pipe is being charged, air enters the signal valve at X, and, passing through small port J, charges chamber A. It also passes through passage CC and feeds down slowly to chamber B, charging it to the same pressure as chamber A. The pressures in chambers A and B and the signal pipe are equal when the signal line is fully charged. When the signal cord is pulled and a reduction is made in the signal line pressure, it also causes a reduction of pressure in chamber A of the signal valve, but passage CC being very small the pressure in chamber A above diaphragm SV 3 reduces faster than the pressure in chamber B, consequently the diaphragm and uprights AA are forced upward, and raises exhaust

valve SV 8 from its seat, thus permitting the air in chamber A to flow into passage E leading to the whistle, which causes a blast. The same reduction of pressure that operates the signal valve also opens the reducing valve, which then allows the pressure from the main reservoir to pass through the reducing valve and into the signal line, raising the pressure to normal. This increase of pressure following immediately after the reduction in the signal line increases the pressure in chamber A faster than in chamber B thus forcing the diaphragm downward and permitting exhaust valve SV 8 to close passage E, thus stopping the flow of air to the whistle.

All other parts of the New York air signal equipment not mentioned herein are interchangeable with and operate upon the same principle as those of the Westinghouse air signal equipment previously described.

DEFECTS OF THE NEW YORK AIR SIGNAL SYSTEM.

Although there are comparatively few parts in the air signal system, it requires good judgment to locate defects that will cause improper operation of the parts.

If the signal system fails to charge it should first be noted that the signal line cocks between the first car and tender are open; if open, the lining of the hose may be loose, blocking the passage, and if in cold weather the signal line on the engine and tender may be frozen up, or not cut in, or the regulating spring of the reducing valve may be broken.

If the signal line charges but fails to respond when

a reduction is made, it may be due to the clogging up of the strainer in the tee pipe connection of the branch pipe with the signal pipe. If this is the case the exhaust may sound all right, as there will be considerable air in the branch pipe between the strainer and the discharge valve, but the air in the main pipe will be unable to flow past the strainer fast enough to make the reduction sufficiently quick to operate the signal valve; or it may be that the small port of the signal valve is stopped up, preventing the air from entering the chamber above the diaphragm and charging the valve; or the small port in the stem of the diaphragm may be stopped up, which will allow the chamber below the diaphragm to charge, but when a reduction is made in the signal line there would be no pressure under the diaphragm to raise the valve from its seat, and no blast of the whistle would result.

A failure of the whistle to sound when a proper reduction has been made, may be due to an improper adjustment of the bell of the whistle, the bowl becoming filled with dirt or by the whistle being placed in such a position that a draft from an open window will prevent the whistle from sounding.

If the whistle gives one long blast when a reduction is made, it may be due to the reductions being made too close together or by the disk becoming loose from its seat.

If the whistle blows when the brakes are released it indicates that there is a direct communication between the main reservoir and the signal line, allowing the signal line to become charged to main reservoir pressure. In releasing the brakes the pressure in the main reservoir is reduced, which will allow the pres-

sure in the signal line to flow back into the main reservoir, causing the signal valve to operate and the whistle to sound. The opening between the signal line and the main reservoir may be caused by the regulating spring being set down too tight, a leak by the diaphragm with the vent port in the spring box being stopped up, or the supply valve being held from its seat by dirt or other foreign matter.

AIR BRAKE EXAMINATION—QUESTIONS AND ANSWERS.

Q. What is considered standard brake pipe pressure?

A. 70 pounds with the ordinary brake and 110 pounds with the high speed brake.

Q. What is excess pressure?

A. Excess pressure is the amount of pressure carried in the main reservoir over and above that in the brake pipe.

Q. What is the amount of excess pressure which should be carried with the various classes of trains?

A. 20 pounds for passenger trains and 20 to 30 pounds for freight trains.

Q. What is the purpose of excess pressure?

A. Excess pressure is carried to insure prompt release of all brakes especially with long trains and to insure quick recharge of brake pipe and auxiliary reservoirs.

Q. Why should a greater excess pressure be carried for freight than for passenger trains?

A. A greater pressure is required for freight trains, as there is a greater volume of air to control, a larger number of auxiliary reservoirs to recharge, and it is more difficult to release on a long than a short train.

Q. Where is the compressed air stored on freight and passenger equipment, and what are its uses?

A. Brake pipe pressure is stored in the brake pipe and is used to charge and recharge the auxiliary reservoirs, apply and release the brakes and assist in apply-

ing the brakes in the emergency application with the old type quick action triple and in service and emergency application with the "K" triple valve.

Auxiliary pressure is stored in the auxiliary reservoir; its duty is to operate the quick action parts of the triple, set the brake and also charge the water pressure on tourist cars which are so equipped.

Signal line pressure is stored in the signal line and in chambers A and B of the signal valve, and is used to transmit signals from trainmen to enginemen.

Q. Where do the different pressures begin and end?

A. Brake pipe pressure begins at the engineer's brake valve and ends at the first closed angle cock in the train, the conductor's valve of the coach or way car the plain side of the triple piston and in chamber Y.

Auxiliary pressure begins at the auxiliary side of the triple piston and ends in the auxiliary reservoir, the water pressure governor of Pullman and Tourist cars, and the face of the slide valve.

Signal line pressure begins at the signal line side of the signal reducing valve and ends at the first turned cut-off cock in the train, at the car discharge valves of all coaches and in chambers A and B of the signal valve.

Q. How much time is ordinarily consumed in charging the auxiliary reservoirs?

A. It usually takes from two to two and one-half minutes on short trains, and with long trains from five to ten minutes.

Q. When should trainmen take into consideration the time required to charge auxiliaries?

A. While charging the train at terminals before testing the brakes and when adding air brake cars to the train when on the road.

Q. When coupling engines to trains which have been charged with air, which angle cock should be opened first?

A. The angle cock on the engine should be opened first when coupling to charged cars, for the reason that if the angle cock on the cars was opened first, the air which fills the hose being drawn from the train line would set the brakes on all of the cars coupled, while if the angle cock on the engine was opened first, filling the empty hose, the engine brakes only would be set slightly, and would not cause as great a waste of air as the setting of all of the brakes on the charged cars.

Q. When coupling empty cars to cars which have been charged with air, how should the angle cock be opened?

A. The angle cock on the empty cars should be opened before the angle cock on the charged cars, and then opening the angle cock on the charged cars very gradually in order not to set the brakes in the emergency. The cutting in of the empty cars will set the brakes on the charged cars in service application, but they can be released very easily by the engineman with only a minimum waste of air.

Q. When picking up air brake cars, when should the air be cut in?

A. Immediately after being coupled to, all hose should be coupled up and angle cocks cut in except the rear angle cock which should be closed. The cutting in of the air on the siding will usually allow

sufficient time for the cars to become charged before being coupled to the balance of the train, and will be in readiness for the air brake test to be made.

Q. If an angle cock is only partly open or there is any obstruction in the brake pipe, how will it affect the operation of the brakes?

A. An emergency application of the brakes could not be made behind the partly closed angle cock or the obstruction, as the triple valve can only be brought into quick action by a sudden reduction of brake pipe pressure, which could not be produced from the engine, as the air would flow past the obstruction or partly closed angle cock too slowly to bring the triple valve into quick action service.

Q. If a car had been cut out by the use of the cut-out on account of a defective triple, and the cut-out cock was found to be defective to the extent that air would leak past it, charging the auxiliary reservoir, and causing the brake to set, what action should be taken by the trainmen?

A. The brake should be disconnected at the dead levers or connecting rods, which will eliminate the necessity of switching the car to the rear end of the air cars, and leaving the hose disconnected.

Q. What precaution should be taken by trainmen to prevent accidents or personal injury when going under cars for the purpose of adjusting the brakes or working with the brake rigging?

A. The cut-out cock in the cross-over pipe should always be closed and the auxiliary reservoir drained of its air, which will prevent the setting of the brake by reason of a burst hose or any reduction which might be made in the brake pipe during the time the

employe was working with the brake rigging. The turning of the angle cocks at each end of the car will answer the same purpose providing the auxiliary and brake pipe are drained of their pressures.

Q. Should one or more cars refuse to release with the balance of the brakes, what is the probable cause?

A. If there are no leaks or other defects in the triple valve, the failure of the brakes to release is usually due to short piston travel, which causes the brake cylinder and auxiliary reservoir to equalize at a higher pressure than those on the balance of the train. This trouble can be remedied by letting out the slack by means of the dead levers so that the piston travel will not be less than six inches.

Q. How do leaks in the brake pipe or hose connection affect the brakes?

A. Leaks of this nature will cause the brakes to apply slowly except that the air pump is able to overcome the leaks and maintain normal pressure in the brake pipe. Brake pipe leaks will also cause the brakes to gradually set with greater force after a service application has been made, preventing the engineman from having control of the brakes.

Q. Is the practice of passing along the train and opening all the bleed cocks a good or bad one?

A. It is bad practice, for the reason that the opening of the bleed cocks, causing a blast of air, does not indicate that the brake is in working order and in addition it is a waste of air pressure and is liable to cause a leakage in the auxiliary reservoir, which will cause the brake to release and a loss of braking power on that particular car.

Q. What is the best method of locating a spongy or perforated hose?

A. A perforated hose can be found by passing the palm of the hand over the hose or using water on the hose, which will cause slight bubbles to rise. A spongy or perforated hose is one of the most troublesome and difficult leaks to locate encountered in the air brake system, as the leakage is very seldom loud enough to be detected by sound.

Q. What is the first duty of the trainmen when the train breaks in two or an air hose burst?

A. His first duty will be to turn the angle clock on the rear cars of the section ahead of the defective hose or where the train has parted, which will permit the engineer to release the brakes on that portion of the train and accumulate enough excess pressure to release the brakes on the rear section when the train is again recoupled or defective hose has been renewed.

Q. How should the angle cocks on cars be left when bleeding the cars for the purpose of making flying switches or other way-switching?

A. They should always be left open and the auxiliary drained of its air, which will prevent the brakes from setting automatically.

Q. If there is a broken brake pipe on a passenger car, necessitating switching the car to the rear of the train, in what position should the angle cock be left?

A. It should be closed on the head end of the car, the hose coupled and the angle cock opened at the rear of the car to which the disabled car is coupled, which will cause the brakes to set automatically and stop the train in the event the disabled car breaks loose from the train.

Q. Are the brake pipe and auxiliary pressures always equal?

A. Brake pipe and auxiliary reservoir pressures are equal only when both are charged and in lap position of the brake valve.

Q. From what source is the air obtained which enters the brake cylinder?

A. From the auxiliary reservoir in service applications, from both the brake pipe and auxiliary reservoir in an emergency application, and from the brake pipe and auxiliary reservoir in service and emergency applications with the "K" type triple valve.

Q. What is the proper piston travel for passenger and freight cars?

A. The proper travel is from six to eight inches.

Q. How is the slack in the brake rigging adjusted?

A. Slack in the brake rigging is taken up on passenger cars by means of turnbuckles, dead levers or patent slack adjuster; on freight cars by dead levers, or bottom rods for inside connected brakes.

Q. What effect has the piston travel on the braking power of the brakes?

A. The braking power of the brakes is dependent largely on the piston travel; the shorter the piston travel, the greater the braking power, and the longer the piston travel, the weaker the braking power.

Q. With the same piston travel, is the same braking power exerted with an empty as with a loaded car?

A. The holding power of the brakes will be alike on empty and loaded cars, but an empty car will be brought to a stop in much less distance than the loaded car, as the brakes must overcome the weight of the load in addition to the momentum of the car.

Q. Will wheels generally slide at high or low speeds?

A. Wheels usually slide at low and not at high speeds, as the friction between the wheel and brake shoe increases as the speed of the wheel decreases.

Q. Should trainmen always observe the wheels when starting from a terminal and when starting after the train had been standing for an unusual length of time en route during freezing weather?

A. Trainmen should always examine the car wheels to see that no brake shoes are frozen to the wheels, which can be detected when the train is starting by watching the wheels to see that they revolve.

Q. Are the wheels of a passenger car more liable to slide than those of a freight car?

A. There is a greater liability of wheels of a passenger car sliding than those of a freight car, as the passenger car has a braking power with an emergency application of ninety per cent. of its light weight, while the braking power of empty freight cars is seventy per cent. of their light weight.

Q. Where did the triple valve derive its name from?

A. The valve receives its name from the three distinct operations that it performs in response to variation of brake pipe and auxiliary reservoir pressures, which are, charging the auxiliary reservoir, applying the brakes and releasing the brakes.

Q. What is the principle upon which a triple valve acts?

A. The greater pressures governing the lesser.

Q. Is there any difference in the action of the quick action triple and plain triple valve in a service application?

A. There is no difference whatever in service application, as their action and the parts employed are identical, with the exception of the additional ports placed in the slide valve of the quick action triple, but which are used only in an emergency application of the brake.

Q. In what manner is the brake apparatus charged?

A. As the air flows from the main reservoir through the brake and reducing valves into the brake pipe throughout the train, a cross-over pipe connects the brake pipe to the triple valve, the pressure from the brake pipe passing into the triple, thence through the feed groove into the chamber where the slide valve is located, and thence into the auxiliary reservoir.

Q. How long does the air continue to flow into the auxiliary?

A. Until the pressure in the brake pipe is greater than that in the auxiliary, or until the pressures are equal on both sides of the triple piston.

Q. What action must be taken to cause the triple piston to move from release position?

A. Any reduction in brake pipe pressure will cause the piston to move from release position.

Q. Why does a reduction in brake pipe pressure cause the triple to respond?

A. As auxiliary pressure is then greater, it forces the triple piston toward the lesser pressure.

Q. What is the action of the triple piston when it moves from release position?

A. It first closes the feed groove and moves the graduating valve from its seat; the lug on the opposite end of the piston stem has then come in contact with the slide valve, causing it to move with the piston and graduating valve, closing the exhaust port, and continuing to

move until the projecting stem of the piston strikes the stem of the graduating spring.

Q. When the stem of the triple piston rests on the graduating stem, what position has the slide valve assumed?

A. The slide valve has assumed a position over the service port, and, the graduating valve having been pulled from its seat when the piston first moved, the auxiliary pressure is now free to pass through the port in the slide valve, called the service or graduating port, which leads to the brake cylinder.

Q. How long does the graduating valve remain off its seat, allowing auxiliary pressure to flow into the brake cylinder?

A. Just as long as auxiliary pressure is the greater, the graduating valve will remain unseated; as the auxiliary pressure expands into the brake cylinder it gradually becomes less; when the brake pipe pressure becomes enough greater than that in the auxiliary, it overcomes the friction of the triple piston packing ring, and the piston automatically moves back and seats the graduating valve.

Q. Does the slide valve move when the piston seats the graduating valve?

A. It does not, as the difference in pressure between the auxiliary and brake pipe is just enough to overcome the friction of the triple piston, but not enough to overcome the friction of the slide valve, which would allow the slide valve to remain stationary when the graduating valve is closed.

Q. How do the pressures now stand in the auxiliary and brake pipe?

A. They are practically equal, although the auxiliary pressure was a trifle less in order to allow the triple piston to move back sufficiently to seat the graduating valve.

Q. What action must be taken to apply the brakes with greater force?

A. An additional reduction of brake pipe pressure must be made.

Q. How does an additional reduction of brake pipe pressure cause the brake to become set harder?

A. The auxiliary pressure again being the greater, forces the triple piston toward the lesser pressure until it is again stopped by the graduating stem, the movement of the piston being just sufficient to unseat the graduating valve, allowing the same amount of pressure to pass from the auxiliary to the brake cylinder as was taken from the brake pipe. When the pressure in the auxiliary becomes slightly less than that on the brake pipe side, the piston will again seat the graduating valve.

Q. How often should brake pipe reductions be made to fully set the brake?

A. Until the pressures have equalized between the auxiliary and brake cylinder.

Q. After the pressures have equalized between the brake cylinder and auxiliary, will any further reduction cause the brakes to be set with greater force?

A. Any further reduction of brake pipe pressure would only cause a waste of air, as there is no further power in the auxiliary to set the brakes with any greater force.

Q. What action is necessary to cause a release of the brake?

A. It is necessary to produce a greater pressure on the brake pipe side of the triple piston than on its auxiliary side.

Q. How is this accomplished?

A. By moving the engineer's brake valve to release position so as to connect main reservoir pressure with that of the brake pipe, which allows all excess pressure to flow from the main reservoir to the brake pipe, causing the pressure on the brake pipe side of the triple piston to be sufficiently increased to overcome auxiliary pressure and force the triple piston to release position, carrying with it the slide valve and graduating valve and opening the exhaust port from the brake cylinder to the atmosphere, causing the brakes to release.

Q. The feed groove leading from the brake pipe side of the triple piston to the auxiliary being very small, how long will it take to charge the auxiliary reservoir from zero to a pressure of seventy pounds?

A. About seventy seconds with a brake pipe pressure of seventy pounds.

Q. Can a train of fifteen cars or more be charged as quickly as four or five cars?

A. They can, providing the pump is able to maintain the seventy-pound brake pipe pressure; if not, it will require more time.

Q. Why are the feed grooves not made larger in order that the auxiliary may be charged more quickly?

A. The object in not making the feed grooves larger is to provide for charging all auxiliaries alike at the same time. On long trains, if the feed grooves were larger, the auxiliaries on the head end of the train would charge faster than those on the rear; also if the grooves were larger, the triple piston would not respond to a reduction

in brake pipe pressure as promptly as with the smaller groove, as the air would feed back into the brake pipe to some extent when a light reduction was made.

Q. What kind of reduction is required to set the brakes in emergency?

A. A sudden reduction at the triple valve.

Q. Are plain triples still used?

A. They are used at the present time, but exclusively on engines and tenders.

Q. What is the action of the quick action triple in emergency application?

A. A quick brake pipe reduction causes the auxiliary pressure to force the triple piston the full length of its travel, compressing the graduating spring on account of its inability to withstand the sudden impact from the triple piston.

When the triple piston has traveled to its extreme position, the emergency port of the slide valve is in front of the port leading to the brake cylinder, and at the same time the removed corner of the slide valve is in front of the port leading to the top of the emergency piston, allowing auxiliary pressure to enter and forcing the piston downward and unseating the emergency valve. This valve being unseated, allows all pressure to escape from cavity Y. With no pressure in cavity Y to hold the brake pipe check to its seat, brake pipe pressure unseats the valve and air passes into cavity Y and over the seat of the emergency valve into the brake cylinder, and at the same time auxiliary pressure is entering the cylinder through the service port S. As soon as the pressures in the brake cylinders and brake pipe have equalized, the emergency piston, rubber seated valve and check valve will return

to their normal positions, the auxiliary pressure continuing to flow into the brake cylinder until the pressures between the auxiliaries and brake cylinder are equal.

Q. As the brakes are set with greater force in an emergency than in a service application, by reason of using a portion of the brake pipe pressure, will the brakes be more difficult to release than when set in a service application?

A. The quick action triple valves will be harder to release, as air from the brake pipe assisted in setting the brakes in emergency, the brake cylinder pressure equalizes higher than in service; therefore, the brake pipe pressure must be made higher to overcome the auxiliary pressure and force the triple piston to release position.

Q. After a partial service application has been made, can a quick action of the brakes be produced?

A. That would depend on the amount of reduction that has been made in service. As a rule, there is very little gained in making an emergency application after a service reduction in brake pipe pressure has been made, but by using the emergency after a partial service application, the brakes will be applied in full service more quickly than with a continued service reduction.

Q. How must a reduction be made in brake pipe pressure to cause the triple to assume quick action position?

A. A reduction in brake pipe pressure must be faster than the auxiliary pressure can pass to the brake cylinder through the service port in the slide valve, in which case the graduating spring cannot withstand

the pressure of the triple piston, which will allow it to travel full stroke, bringing the quick action parts into service.

Q. Why is port S in the slide valve, which is brought into service in an emergency application, made smaller than port Z used in service application?

A. This port is made smaller in order to retard the auxiliary pressure and allow as much air as possible to enter the brake cylinder from the brake pipe before the pressures equalize between the brake pipe and cylinders, which causes the quick action parts to return to their normal positions and allows auxiliary reservoir pressure to continue feeding to the brake cylinder until their pressures are equal.

Q. If four or more cars which are cut out or two dead engines are together in the train, can a sufficiently sudden reduction be made at the first working triple behind the cut-out cars to cause the triples beyond to assume emergency position?

A. As a rule they would not assume emergency position on account of the frictional resistance of the air passing through the brake pipe, which would prevent a sudden reduction at the first quick action triple valve back of the cut-out cars.

Q. What would be the effect of a weak or broken graduating spring?

A. On short trains, there would be nothing to stop the triple piston when it reached service position, and it would continue to move to emergency position.

Q. Will a weak or broken graduating spring always cause the triple to be thrown into quick action?

A. No, only with short trains, for the reason that with a service brake pipe reduction, air is drawn from

the brake pipe faster than the auxiliary pressure can pass to the brake cylinder through the service port in the slide valve, and when the auxiliary pressure is enough greater than that in the brake pipe, it forces the triple piston to emergency position, by reason of there being no resistance from the graduating spring, but on long trains it requires more time to make a corresponding reduction on account of the larger volume of air in the brake pipe. The auxiliary pressure is given a longer time to pass into the brake cylinder, resulting in the brake pipe and auxiliary pressures remaining about equal, which prevents the triple piston from moving to emergency position.

Q. About how many cars must there be in a train so that a broken or weak graduating spring will not have an appreciable effect on the operation of the brakes?

A. Usually not less than six or seven.

Q. What are the defects in a triple valve that will cause it to go into quick action regardless of the length of the train?

A. A sticky triple or broken graduating pin.

Q. Why will a sticky triple cause the brakes to go into emergency?

A. Because the triple does not respond to the first and at times to the second service reduction. When a further reduction is made, the triple is suddenly forced from its release position, and the graduating spring not being strong enough to overcome the impact of the triple piston, allows the triple to travel to emergency position, causing the brakes on that particular car to set in quick action, which will cause the

next triple to assume emergency position, and so on throughout the train.

Q. Why will a broken graduating pin cause the triple to assume emergency position?

A. With the graduating pin broken, there is no other means of moving the graduating valve from its seat. When the triple valve moves, the auxiliary pressure tends to hold the graduating valve to its seat, which will not allow the air to pass from the auxiliary through the graduating or service port of the slide valve to the brake cylinder. When a sufficient brake pipe reduction has been made so that the graduating spring cannot withstand the auxiliary pressure acting upon the piston, the triple will move until it assumes quick action position, causing the brakes to be set in emergency, with the resultant effect of all other quick action triple valves in the train assuming emergency position.

Q. What effect will a leak in the auxiliary have on the brakes when in release position?

A. They will have the same effect as a leak in the brake pipe.

Q. What effect will a leak in the auxiliary have when the brakes are applied?

A. It will cause the brakes to leak off and will continue to draw air from the brake pipe through the feed ports, which will result in gradually setting the other brakes with greater force.

Q. What will be the effect of a leaky rubber seated valve?

A. When the brakes are applied, this leak will allow the brake pipe pressure and cylinder pressure to equalize.

Q. What is the usual cause for leaks in a rubber seated valve?

A. The valve held from its seat by dirt or the seat being badly worn or decayed.

Q. What are the defects which will cause a blow at the triple exhaust with the quick action triple valve?

A. The slide valve being held off its seat by scale or dirt, the slide valve seat being cut, gasket 15 between the auxiliary and triple being defective, gasket 25 between the brake cylinder head and triple being in a defective condition, the auxiliary tube *b* in freight equipment being cracked, check case gasket 14 being defective, or a defective rubber seated valve.

Q. What effect will the various leaks above enumerated have on the brake?

A. A slide valve leak, a defective gasket between the triple and auxiliary, a cracked auxiliary tube, or a leaky gasket between the triple and brake cylinder will have the effect of reducing the pressure in the auxiliary reservoir and releasing the brake, while a leaky gasket 14 or a leak in the rubber seated valve 10 will reduce the brake pipe pressure and tend to set the brake with greater force.

Q. How can the various blows at the triple exhaust be distinguished?

A. A ten-pound reduction should be made. If the blow stops and the brake sets harder, then releases, and the blow then starts again at the exhaust, the trouble is due to a leak between the triple and auxiliary or between the triple and brake cylinder, or it may be caused by a cracked auxiliary tube; but if the blow continues and the brake releases, it is due to a

defective slide valve, while if the blow stops and the brake sets harder and does not release it indicates a leak at gasket 14 or at the rubber seated valve.

Q. Are there other defects in the triple valve which will cause the brake to release?

A. Other defects which will cause a release of the brakes are a leaky bleed cock in the auxiliary reservoir, a leak in the pipe connection leading from the triple valve to the auxiliary or in the pipe connection leading from the triple valve to the brake cylinder, the packing leather in the brake cylinder becoming worn, the piston not covering the leakage groove, or a leak between the brake cylinder head and cylinder.

Q. What are the duties of the triple piston?

A. The duties of the triple piston are to open and close the feed grooves and guide the movement of the slide valve and graduating valve, and it also forms a dividing line between the auxiliary reservoir and brake pipe pressures.

Q. What are the duties of the slide valve?

A. The duties of the slide valve are to open and close communication between the auxiliary reservoir and the brake cylinder and to open and close communication between the brake cylinder and the atmosphere, in conjunction with the graduating valve and triple piston. It is also the duty of the slide valve in the quick action triple to open and close communication between the auxiliary reservoir and the emergency piston.

Q. What is the duty of the graduating valve?

A. To graduate the flow of air from the auxiliary reservoir to the brake cylinder, in conjunction with the slide valve and triple piston.

Q. What is the new type of triple valve called?

A. It is called the improved "K" triple valve.

Q. Does this valve differ in principle and operation from the old standard triple valve?

A. No, the valve operates on the same principles as the old valve; that is, a reduction of brake pipe pressure causes the brake to apply and an increase of brake pipe pressure causes it to release.

Q. What are the most important advantages of the improved valve over the old type?

A. A portion of the brake pipe air is vented to the brake cylinder in each service application, resulting in a quicker reduction of pressure in the brake pipe throughout the train and a quicker serial application of the brakes than is obtained with the old triple. When the brakes are released on long trains, those on the front portion may be held applied for a period of time, allowing the brakes on the rear of the train more time to become released. There is also a retarded recharging feature in this valve which retards the recharge at the head end of the train, resulting in a greater amount of air being available with which to release and recharge the brakes at the rear of the train. This type of valve also does away with the objectionable feature of the old valve in that it prevents the auxiliary reservoirs at the head end of the train from becoming overcharged, which overcharge usually results in a reapplication of the brakes near the head end of the train when the brake valve is moved to running position, necessitating a second release of the brakes.

Q. When an emergency application of the brakes has been made, is there any advantage of the new triple valve over the old one?

A. The emergency feature of the triple valves has not been changed, and the results obtained are practically identical with both valves.

Q. When making a service application of the brakes with a 70-pound brake pipe pressure, how much reduction is required to fully set the brakes?

A. About seventeen pounds, or three pounds less than with the old triple.

Q. Will the "K" type triple give satisfactory results when mixed with a number of the old style triples?

A. It will give satisfactory results in any part of the train, and, in fact, it will very materially improve the action of the old triple.

Q. How many sizes of the "K" triple are there in use?

A. Two—the K1 and the K2.

Q. On what size car equipment are the K1 and K2 used?

A. The K1 is used on 8-inch freight equipment and the K2 on 10-inch equipment.

Q. Can a K1 and a K2 be substituted for the corresponding size of the old style triple?

A. They are interchangeable on their respective reservoirs.

Q. On a train of 70 to 90 cars, will a 5-pound service reduction cause all the brakes to set in service application?

A. A 5-pound reduction will cause all brakes to apply, and they will be as effective in stopping a train at the speed of 15 or 20 miles per hour as a 10 or 15-pound service reduction with the old style triple valve.

Q. Are the defects and troubles of the "K" type triple the same as with the old type triple valve?

A. They are practically the same, and can be located and remedied in the same manner.

Q. What is the difference between an application and a reduction?

A. An application consists of a number of reductions without releasing the brakes and may be made several times during an application.

Q. How should the air brake equipment be tested for leaks?

A. A brake pipe reduction of about 15 pounds should be made. If the brake releases, it indicates a leaky auxiliary reservoir or a leaky graduating valve. If the brakes leak off, and there is no sound at the triple exhaust, there is a leak in the pipe connection leading from the triple to the brake cylinder, a leak at the leather gasket to the brake cylinder, or a leak in the brake cylinder or head. If the car is equipped with a high speed reducing valve and the brake releases, it may be due to a defective valve or a leak in the pipe connection leading to it. Leaks can also be detected by making a service application of the brakes and examining all pipe connections and joints with a torch while the brakes are applied.

Q. After making a full service application, how much pressure is there in the brake cylinder?

A. With an eight-inch piston travel and 70 pounds brake pipe pressure, and a reduction of 20 pounds in brake pipe pressure is made, the auxiliary, brake cylinder and brake pipe air will equalize at about 50 pounds.

Q. Will a 10-pound reduction from a brake pipe pressure of 65 pounds set the brake with a greater force than a 10-pound reduction from a brake pipe pressure of 50 pounds?

A. A 10-pound reduction from a brake pipe pressure of 65 pounds will not apply the brakes with greater force than a 10-pound reduction from a 50-pound brake pipe pressure, as there is a pressure of only 10 pounds going into the brake cylinder, and it is above the equalizing point of the two pressures.

Q. How can a greater pressure be secured in the brake cylinder?

A. By the use of higher brake pipe pressure, shorter piston travel and the use of the emergency with the quick action triple; also by the use of the retainers after a second service or emergency application has been made.

Q. What is meant by an over-reduction?

A. An over-reduction is one in which the brake pipe pressure is reduced below the point at which the auxiliary reservoir and brake cylinders equalize.

Q. What is the result in air brake practice of making an over-reduction?

A. It results in a useless waste of brake pipe air and an irregular and often a difficult release of the brakes.

Q. How much pressure is it necessary to add to the brake pipe to release the brakes?

A. To release the brakes it will be necessary to raise the brake pipe pressure the entire length of the train above the pressure in the auxiliary reservoir pressure. A slight difference in the pressure is usually sufficient to overcome the frictional resistance of the triple piston and slide valve.

Q. How much time is required for the brakes to release?

A. Usually about one-half second for each car in the train.

Q. How much pressure must be admitted to the brake pipe to release the brakes when an over-production has been made?

A. It will be necessary to increase the brake pipe pressure the amount of the over-reduction plus the amount required to overcome the resistance of the triple piston and slide valve.

Q. How many applications of the brakes should be made to stop a train?

A. It is advisable on passenger trains to make two applications, which insures a more smooth and accurate stop without danger of wheel sliding. More than one application is not advisable on a freight train, for the reason that on long freight trains with the old style triple valves the head brakes will release before the rear brakes, allowing the slack to run out with consequent danger of breaking in two.

Q. At what times should an emergency application be made?

A. Only in cases of actual emergencies to prevent an accident.

Q. At what time is an emergency application the most effective on a train—at fast or at slow speed?

A. At slow speed, as the friction between the brake shoe and wheel is greater at slow than at high speed.

Q. How many air brake cars should be operated by one engine?

A. All air brake cars in the train should be in service and must represent at least 75 per cent. of the total number of cars in the train.

Q. Can an engineman tell approximately by a five or six-pound reduction about how many air brake cars are coupled?

A. An engineman can tell approximately how many cars are coupled up by the length and strength of the brake pipe exhaust, but he cannot tell how many cars are cut in or working.

Q. What are the joint duties of enginemen and trainmen in making tests of the brakes?

A. When testing the brakes on freight trains, the engineman should have full pressure in the main reservoir when coupling onto the train. The brakeman should open the angle cock on the tender and note that there is a good blast of air before coupling the hose; after the hose is coupled, the angle cock should be opened gradually. When the train is charged, the rear brakeman stationed at the rear air car should transmit the signal to apply the brakes to the head brakeman, who should repeat the signal to the engineman, who will then make a 25-pound brake pipe reduction. After the brakes have been applied, the head and rear brakemen should walk toward one another, inspecting the brake on each car to see that it has applied, noting the piston travel and looking for brake pipe, cylinder and auxiliary leaks. When the brakemen meet, they should signal the engineman to release the brakes and then return to their respective ends of the train, noting that all brakes have released. If any brake fails to release, it should be cut out, carded and the auxiliary reservoir drained of its air.

Q. How should a terminal test be made on a passenger train?

A. The same rule should be followed as with a freight train, but in addition the air signal line should be tested. The brakeman should pass through the train testing the car discharge valve of each coach, he should give the engineman the hand signal to apply the brakes

from the head end of the train, and then pass along the train inspecting the brakes to see that they are applied. After reaching the rear of the train, he should signal the engineman to release the brakes by giving four distinct blasts of the air whistle, and then return to the head end of the train, noting that all brakes are released.

Q. What is meant by a running test, and how should it be made?

A. When a train leaves a terminal or a change is made in the make-up of a train, the engineman should make a running test of the brakes after the train has moved a train length, by applying the brakes with the throttle open. As soon as all brakes are felt to take hold, they should be released.

Q. At what other times should a running test be made?

A. This test should be repeated when engines are changed, adding a double-header, after long delays on the road, when air cars are added to or set out from the train, when the engine is cut off and when the train has been cut at a crossing.

Q. When should a two-mile running test of the brakes be made?

A. The two-mile running test should be made before descending heavy grades and when approaching tunnels, meeting points, railroad crossings, junction points, interlocking plants, ends of double track and other dangerous localities where a stop may be required.

Q. In testing the brakes, should an emergency application be made?

A. Emergency applications must not be made when testing brakes, as some brakes will set in the emergency that would not set in a service application; it would

also cause a waste of brake pipe air, making it difficult to release the brakes.

Q. Why should a full reduction be made when making a standing test instead of five or six pounds?

A. A five or six-pound reduction will not be sufficient to force the pistons by the leakage grooves on a long train; also with a light reduction, the brakes on cars that have not been fully charged will not apply and it would not be possible to get full piston travel, as would be the case with a full service reduction.

Q. If one triple goes into the emergency when a service reduction is made, will all other triples apply in quick action?

A. If one triple goes into the emergency position, all others will follow, as the sudden reduction of brake pipe pressure rushing to the brake cylinder will cause the other triples of either type to go into emergency.

Q. How can a defective triple be located?

A. To locate a defective quick action triple on a train of from five to ten cars, the engineman should make a five-pound brake pipe reduction, and the car on which the brake does not set should be located. When the car is located, a further reduction should be made, and if the brake on this particular car sets in quick action, it should be cut out and carded; the entire train should then be recharged, and another test made. On long trains it will be necessary to make sectional tests, cutting in ten or twenty cars with each test, and proceeding as above described.

Q. Why, in making a terminal test, should the brakes be held set until thoroughly inspected by the trainmen?

A. The longer a brake remains applied, the more certain an engineman and trainman can be that it will hold for a long, hard stop. A brake that will not remain applied for one minute or longer is considered a poor brake and it should be carded.

Q. Should the brakes be left set or released before detaching the locomotive from the train?

A. The brakes should always be released and hand brakes used to hold the train if necessary. The air brakes should never be depended upon for holding the train on a grade when the engine is detached.

Q. What are the usual causes of the brakes dragging or failing to release?

A. This trouble is usually due to leaks or insufficient excess pressure, especially on long trains. Another frequent cause of brakes dragging results from enginemen moving the brake valve from running to release position in trying to release imaginary brake dragging. At times a heavy leakage from the brake pipe occurs when trains are stretched after standing, particularly in cold weather when the air hose becomes frozen.

Q. How should a train be handled by trainmen when using the tail hose?

A. When a tail hose is to be used to control the brakes on passenger trains when backing up, the terminal test of the air brakes should be made by the engineman, and a test of the tail hose should then be made by the trainman stationed on the rear car, the test by the trainman to be made after the train is in motion, the first application being made about 200 feet from the starting point. The valve of the tail hose should be opened slowly and the opening gradually increased until the valve is wide open or the train has slowed down as

much as desired or has been brought to a stop. This valve should not be opened and closed; if the application has been too strong, the closing of the tail hose valve will allow the brakes to release and recharge. The rapidity with which the valve is opened must be determined by the speed, the length of the train and the distance within which it must be stopped. In cases of emergency, the valve should be instantly opened to its full extent.

Q. When two or more engines are coupled together, which engineman should do the braking?

A. The engineman on the leading engine should always do the braking.

Q. When should hand brakes be used on the rear of a freight train?

A. Only upon a signal for brakes and when a train consisting of part air cars is backing, the hand brakes should always be used to furnish most of the braking power required. If the engineman requires additional braking power on account of not having a sufficient number of air brake cars, the hand brakes immediately behind the air cars should be used when going ahead.

Q. Should the brakes be released on a long freight train after it has been reduced to slow speed?

A. When the speed of a long freight train has been reduced to ten or twelve miles per hour, it is considered the best policy to come to a full stop before releasing. If, however, the engine is equipped with the combined straight air and automatic brake, the ET equipment or the New York brake valve, the engine and tender brakes can be applied and the automatic brakes released without danger of parting the train even at slow speeds.

Q. What is the purpose of the train air signal?

A. To permit prompt and accurate signaling from the trainmen to the enginemen on passenger trains.

Q. What is the power which causes the whistle to sound?

A. Compressed air pressure.

Q. What are the essential parts of the air signal equipment?

A. The pressure reducing valve, the signal valve, the car discharge valve, whistle and the necessary amount of piping.

Q. What is a pressure reducing valve, and what are its functions?

A. It is a valve connected to the main reservoir, and its purpose is to supply the signal system at a lower pressure than that in the main reservoir.

Q. What is considered standard pressure for the signal line?

A. The best results are obtained by using a pressure of about 40 pounds, which is considered standard.

Q. How should a reduction in the signal pipe be made to cause the whistle to sound properly?

A. A short, quick exhaust or reduction is necessary to cause the whistle to sound distinctly, while a long, gradual reduction will not cause it to sound.

Q. Why will the signal valve fail to cause a blast at the whistle when a slow, gradual reduction is made?

A. With a slow, gradual reduction of signal line pressure, instead of reducing the pressure in the signal line below that in the chamber under the diaphragm, the pressure feeds from this chamber back into the signal line, which removes the power which should operate the signal valve.

Q. What are the operative parts of the reducing valve?

A. Supply valve 4, supply valve spring 6, reducing valve piston 7, piston rod 10, diaphragm 11 and regulating spring 13.

Q. In what manner does the air pass through the reducing valve to the signal pipe?

A. Air enters from the main reservoir at the connection on the main reservoir side, and supply valve 4, being raised off its seat, permits the air to pass by the seat of the supply valve into diaphragm chamber C, and thence through port *b* to the signal pipe connection.

Q. When the desired pressure in the signal pipe has been obtained, how does the reducing valve stop the flow of air from the main reservoir to the signal pipe?

A. Signal line pressure is present at all times on the diaphragm, and when the desired pressure in the signal line is obtained it exceeds the tension of the regulating spring and the diaphragm is forced to its lower position, permitting supply valve spring 6 to seat supply valve 4, shutting off the flow of air from the main reservoir to the signal line.

Q. After the air has passed through the reducing valve, to what part of the signal system does the air then pass?

A. It passes to the signal line throughout the entire train, and also to the whistle signal valve, causing it to become charged.

Q. What is the duty of the signal valve?

A. The purpose of the valve is to regulate the flow of air to the signal whistle.

Q. What are the operative parts of the whistle signal valve?

A. The signal valve consists of two operative parts, namely, the rubber diaphragm 12 and signal valve stem 10.

Q. How does the air pass to the signal valve when the system is being charged?

A. Air enters the signal valve from the signal line, passes through port *d* into chamber A above the diaphragm, also through port C and around piston stem 10 and into chamber B, causing the air pressure to equalize above and below diaphragm 12.

Q. What is the action of the signal valve when a reduction is made in the signal pipe?

A. When a quick reduction is made in the signal pipe, it causes a reduction of pressure in chamber A above the diaphragm, and the pressure in chamber B, then being the greater, causes the diaphragm to raise, lifting signal valve 10 off its seat.

Q. In what manner does the air pass to the whistle causing it to sound?

A. The air pressure in chamber B passes by diaphragm stem 10 and unites with the air pressure passing through port C, thence through port *c* below the valve stem and into the pipe leading to the whistle, which causes a blast.

Q. What is the action of the valve which causes it to close after the blast of the whistle has been given?

A. The same reduction of signal line pressure which causes the signal valve to operate also causes the reducing valve to open, which permits main reservoir pressure to flow into the signal line, restoring the pressure. This raises the signal line pressure and

also causes the pressure to be raised in chamber A, above the diaphragm, moving it to its lower position. Equilibrium of pressures then quickly occurs in chambers A and B, and the valve at the lower end of stem 10 returns to its seat.

Q. How is the pressure in the signal pipe usually reduced to cause the whistle valve to operate?

A. By means of the car discharge valve, it can be operated from any part of the train by means of a cord, known as the whistle cord.

Q. What are the operative parts of the car discharge valve?

A. The operative parts consist of discharge valve 3, discharges valve spring 4 and discharge valve handle 5.

Q. What is the normal position of this valve?

A. The normal position is closed.

Q. How is the car discharge valve operated to exhaust air from the signal pipe to the atmosphere?

A. The valve is operated by means of handle 5, which is in the form of a lever connected to the whistle cord. By pulling this lever in either direction, it forces the discharge valve from its seat, which compresses discharge valve spring 4 and permits the air pressure to escape from the signal line to the atmosphere.

Q. When operating the whistle signal, what length of time should the car discharge valve be held open to cause the whistle to give a distinct blast?

A. The valve should be held open for at least one second to produce a proper blast of the whistle.

Q. How much intermission should be allowed between blasts?

A. An intermission of about three seconds should be allowed between blasts of a train of five cars or less, and one second should be added for each additional car in the train.

Q. Why should the discharge of air from the discharge valve be spaced in this manner?

A. The spacing of the blasts is necessary in order to give the air pressure in the signal valve sufficient time to equalize above and below the diaphragm of the signal valve between each blast of the whistle.

Q. If the signal line fails to charge, what part of the equipment should be examined?

A. If the air fails to pass to the signal line it should first be noted that the signal line has cut in between the tender and the first car and that all angle cocks on the train are open, except the one on the rear end of the train, which should be closed. If the trouble still continues, it is due to a defect in some of the parts attached to the engine or a loose hose lining.

Q. If the signal line is properly charged and the air signal whistle fails to respond when a proper reduction is made, where is the trouble likely to be located?

A. The trouble may be due to the strainer in the tee pipe connection or the branch pipe to the signal line being partly stopped up, or the parts attached to the engine becoming defective.

Q. What is the cause of the air whistle giving one long blast when a reduction is made?

A. It may be due to the reduction being made too closely together or diaphragm stem 10 working stiffly in bushing 9, in which event the passage at *c* would remain open until a sufficient difference of

pressure exists in chambers A and B to force stem 10 to its seat.

Q. What is the cause of an air whistle giving a blast each time the brakes are released?

A. It indicates that the signal line pressure is charged up to that in the main reservoir.

Q. What is the cause and effect of an over-charged signal line?

A. Overcharging of the signal line is usually due to there being a direct opening between the signal line and main reservoir, which will allow air to flow from the signal line to the main reservoir each time the main reservoir pressure is reduced. This will cause a reduction of signal line pressure at the signal valve, which will open the signal valve, causing the whistle to sound.

Q. How can it be detected by the trainmen when the signal line is overcharged?

A. It can be detected from the train by an unusually strong discharge of air from the car discharge valve.

Q. What is the purpose of the brake cylinder?

A. To hold the piston from which the power is developed when the brake is applied.

Q. What are the parts contained within the brake cylinder?

A. Piston head, piston, piston packing leather, expanding ring and piston release spring.

Q. What is the purpose of the packing leather?

A. It is to make an air tight joint around the piston, preventing the air which is admitted to the brake cylinder from escaping by the piston to the atmosphere.

Q. What is the purpose of the expanding ring?

A. It is used to set the packing leather out snugly against the cylinder wall.

Q. What is the purpose of the piston release spring?

A. The purpose of this spring is to move the piston back to its normal or release position after the pressure has been exhausted from the brake cylinder.

Q. Are there any grooves or ports in the brake cylinder?

A. There is a groove called the leakage groove, which is about three inches in length and is cut in the side or top of the brake cylinder.

Q. What is the purpose of the leakage groove?

A. If the exhaust port in the slide valve of the triple valve should in any manner become obstructed or the triple valve moved to service position, closing the exhaust port, a slight flow of air into the brake cylinder will, instead of forcing the piston out, escape through the leakage groove to the atmosphere at the non-pressure end of the cylinder.

Q. What determines the size of brake cylinder to be used on the different classes of equipment?

A. The size of the brake cylinder is determined by the total weight of the empty car resting on the rails.

Q. Where are brake cylinders usually located?

A. Underneath the cars at a point which is the most accessible for repairs and where they can be operated to their best advantage.

Q. What is the purpose of the auxiliary reservoir?

A. It is a place of storage for air pressure with which to apply the brakes on that particular car.

Q. What governs the size of the auxiliary reservoirs used on the various classes of equipment?

A. The size of the brake cylinder.

Q. Why is the size of the reservoir governed by the size of the brake cylinder?

A. In order that the pressure in the reservoir and brake cylinder will equalize at the proper pressure when the brake is fully applied.

Q. What are the defects usually found in brake cylinders?

A. Leakages are the most common defects.

Q. What is the most common cause of leakages in the brake cylinder?

A. The packing leather becoming cut or very dry and not forming an air tight joint between the piston and cylinder wall.

Q. What will be the effect if the expanding ring is not placed in its proper position or is broken?

A. The packing leather will not be held against the cylinder wall, thus permitting a leakage, and it may also bind the piston, preventing it from returning to release position after the pressure has been exhausted.

Q. What will be the effect of a broken or weak piston release spring?

A. A broken or weak release spring will fail to force the piston back to its normal or release position after the pressure has been exhausted from the cylinder.

Q. What will be the effect if the leakage grooves become stopped up?

A. If the grooves should become stopped up and the exhaust port is obstructed, it would possibly cause

the brakes to set slowly if a leak existed to the brake cylinder, as the air which is admitted to the brake cylinder could not escape past the piston.

Q. What is an automatic slack adjuster?

A. It is a simple mechanism attached to passenger equipment, by which a predetermined piston travel is constantly maintained and allows the brakes of each car to do their full amount of work.

Q. What is the necessity of the slack in the brake rigging being taken up as fast as it occurs?

A. By constant wear the brake shoes become thinner, causing the piston to travel further and results in reducing the brake cylinder pressure and the holding power of the brakes.

Q. In what manner is the slack adjusted on equipment not equipped with the automatic slack adjuster?

A. It is taken up in the brake rigging by hand with the dead levers or connecting rods.

Q. As the work of the automatic adjuster is based on running travel, will the standing travel be uniform on all cars?

A. The standing travel of the pistons will not necessarily be uniform on all cars in the train, for the reason that the effect of the movement of the brake rigging and brakes is not the same when standing as when running.

Q. Is the automatic slack adjuster a complicated device?

A. It is not complicated; simplicity is one of its strongest features.

Q. What is the construction of the standard pressure retaining valve?

A. It consists of weighted valve *r* and enclosed in casing 3, and seating in passage *b* this valve is screwed onto the farther end of the pipe leading to the exhaust port of the triple valve.

Q. What is the purpose of the retaining valve?

A. The purpose of the retainer is to hold a given pressure in the brake cylinder after the brakes have been released. A pressure of 15 pounds is considered standard.

Q. What is the position of the retaining valve handle when not in service?

A. Perdendicular position.

Q. What is the position of the retaining valve handle when in service?

A. Horizontal position.

Q. What other features are contained in the retaining valve in addition to retaining 15 pounds pressure in the brake cylinder?

A. In addition to holding 15 pounds brake cylinder pressure, the passageway of the air to the atmosphere in the casing is restricted to such an extent that considerable time is consumed in discharging the brake cylinder pressure through the small port. This renders the release of the brake much slower and exerts a retarding effect, giving more time for the recharging of the auxiliary reservoir.

Q. Is port *d* the same size in all retaining valves?

A. This port varies in size with the various sizes of brake cylinders.

Q. What are the advantages gained by the use of the retainer?

A. It permits a much safer handling of trains, maintains a more uniform rate of speed down heavy

grades and a saving of air pressure; it also furnishes an increased cylinder pressure and a higher braking power, with a lower consumption of air pressure, and in addition permits a greater reserve force in stopping for emergencies.

Q. Why will an application of the brakes with the retainers in use secure a greater brake cylinder pressure than when the retainers are not used?

A. If a 5-pound reduction is made with the retainers not in use, a pressure of about 12 pounds is obtained in the brake cylinders, while with the retainers closed and a second application is made, a pressure of about 15 pounds will be obtained, the extra braking power being due to the pressure retained in the brake cylinder by the retaining valves.

Q. If there is a leakage of pressure at the retaining valve while the brakes are released, where should the trouble be located?

A. The trouble will be found in the triple valve.

Q. If the retaining valve handle has been turned to a horizontal position, the brakes then released and after a few moments the handle is turned down and no air escapes, where should the trouble be looked for?

A. The trouble is not in the retaining valve, but is caused by a leaky joint or connection in the pipe, or by the valve being held from its seat by dirt. If there is no leakage in the retaining valve pipe it indicates a leak in the brake cylinder packing.

Q. If the air should fail to pass through the retaining valve with the handle turned down, and the brake remains set, what is the probable cause?

A. The trouble should be looked for at the exhaust

port, which may have become stopped up by an accumulation of dirt.

Q. In what class of passenger service is the high speed brake used?

A. It was originally designed for fast express and mail trains, but is now being generally used in both local and through passenger service.

Q. How much quicker can a passenger train be stopped when using the high speed brake than when using the ordinary quick action brake?

A. The train can be brought to a stop in about 30 per cent. less distance.

Q. How can a high speed braking power be used without danger of flattening the wheels?

A. There is practically no danger of flattening wheels, for the reason that the brake is applied at maximum pressure when the train is running at high speed, the automatic reducing valve reducing the brake cylinder pressure so that when the speed of the train has been slackened, the brake cylinder pressure has also been reduced to about the same as used with the ordinary quick action brake.

Q. Why will the high speed braking power not slide the wheels when the train is running at high speed?

A. The wheels will not slide, for the reason that the faster the wheels revolve, the greater is the inertia of the wheels which the friction of the brake shoes must overcome before they will cease to revolve, the friction between the wheel and rail remaining about constant at all times, regardless of the speed of the train.

Q. What brake pipe and auxiliary pressures are usually carried with the high speed brake?

A. About 110 pounds.

Q. At what pressure will the auxiliary and brake cylinders equalize when the brakes are set in the emergency with high speed pressure?

A. They will momentarily equalize at about 88 pounds, and a comparatively slow discharge of brake cylinder pressure will take place while the train is at its maximum speed.

Q. How is the brake cylinder pressure of 88 pounds reduced before the train has been brought to a slow speed?

A. The reduction in pressure is accomplished by the automatic reducing valve.

Q. What is the action of the automatic reducing valve in a service and in an emergency application of the brakes?

A. Air that is admitted to the brake cylinder is free to reach the top of piston 4 of the reducing valve, and when the brake is fully set, the pressure in the cylinder being greater than the tension of the regulating spring, piston 4 is forced down and carries the slide valve with it, thus opening the triangular port *b* into port *a*, allowing brake cylinder pressure to escape to the atmosphere. The apex of the triangular port *b* points upward, and as the slide valve is drawn down slightly as in a service application, port *b* at the base has a wide opening into port *a*, allowing cylinder pressure to escape quickly. When an emergency application of the brakes has been made, the high cylinder pressure forces piston 4 downward to its full stroke, which allows the brake cylinder pressure to escape slowly through the small end of port *b*, and as the cylinder pressure is gradually vented to the atmosphere through port *b*, the regulating spring raises the piston and slide valve, causing the pressure to

be released more rapidly through the wider portion of port *b*, it will thus be seen that a slow exhaust from the reducing valve exists while the speed of the train is high, and a quick and more rapid exhaust takes place with slow speeds.

Q. At what pressure is the regulating spring set withstand?

A. It is usually set at 60 pounds.

Q. What changes are necessary to make a high speed brake out of the ordinary quick action equipment?

A. There are no changes to be made, the reducing valve is simply added to the equipment.

Q. With high speed pressure of 110 pounds, is a higher cylinder pressure developed than when 70 pounds is used if a 10-pound service reduction of brake pipe pressure is made?

A. A 10-pound brake pipe pressure of 110 pounds will not apply the brakes with greater force than a 10-pound reduction from a 70-pound brake pipe pressure, as there is only a pressure of 10 pounds being admitted to the brake cylinder in either case, and it is above the equalizing point of the two pressures.

Q. Do the brakes apply any quicker in a service application with a high speed than with the ordinary brake?

A. They do, for the reason that the higher pressure used in high speed brake service will pass through the ports quicker from the auxiliary reservoir to the brake cylinder.

Q. What methods of making station stops will produce the best results with the high speed brake?

A. The two application method should always be

used, the same as when employing only 70 pounds brake pipe pressure.

Q. What other advantages are there in the use of the high speed brake?

A. Two full service applications of 20 pounds each, and releases can be made without recharging the auxiliary reservoir and there will still be the standard 70-pound pressure available with which to stop if necessary.

Q. What defects may exist in the high speed reducing valve which will cause the brakes to release?

A. The slide valve or its seat being cut, broken or improperly adjusted, regulating spring worn out or defective, packing ring 5 or packing leather 20 being defective, or a leak in the pipe connection leading from the brake cylinder to the reducing valve.

Q. Are there any provisions in the high speed reducing calve to prevent port *b* being moved below port *a*, thus maintaining the full pressure in the brake cylinder?

A. The reducing valve is so constructed that when piston 4 moves to its full stroke it is arrested by shoulder 3, thus permitting the valve to be constantly open from the brake cylinder to the atmosphere while the piston and slide valve are in their lower position.

Q. Why is the New York triple called a quick action triple?

A. In an emergency application it carries auxiliary air to the brake cylinder almost instantly, equalizing the pressure through the large opening past the quick action valve. In service application, air passes slowly from the auxiliary to the brake cylinder through the graduating service port only.

Q. What are the principal operative parts of the New York quick action triple in service application?

A. The main triple piston QT 128, exhaust slide valve QT 38, graduating valve QT 48 and vent piston QT 129.

Q. What are the additional operative parts in this triple when an emergency application is made?

A. Vent valve piston QT 129, vent valve QT 131, quick action piston QT 137 and quick action valve QT 139.

Q. Are these parts inoperative in a service application?

A. In service application these parts remain inoperative, but in an emergency application they are carried into action.

Q. How is the brake released with the New York triple valve?

A. In the same manner as the Westinghouse triple valves are released; that is, by restoring the brake pipe pressure until it is greater than that in the auxiliary reservoir.

Q. What is the difference in the operation of this triple in service and in emergency applications?

A. In service application it allows auxiliary pressure to pass to the brake cylinder gradually as required to produce the necessary braking force. In an emergency application it allows the full auxiliary reservoir air to pass almost instantly into the brake cylinder, applying the brakes with full force, and at the same time it vents sufficient brake pipe air to produce a quick reduction in brake pipe pressure, which causes the following triple valve to operate in quick action,

and so on throughout the train, producing quick action upon all the brakes.

Q. Is there a greater pressure produced in the brake cylinder with this valve in an emergency than in a full service application?

A. There is no greater pressure, as this type of triple valve uses auxiliary reservoir air only in both service and emergency applications. No greater brake cylinder pressure is obtained with one application than with another.

Q. After a partial service application has been made, can an emergency application be produced?

A. An emergency application can be produced, but the quick action parts will not operate so as to produce an instantaneous equalization of pressure in the brake cylinder.

Q. As auxiliary air alone passes to the brake cylinder in service or emergency application. will not a full service be as effective as an emergency application?

A. While the brake cylinder pressure would be the same in both applications, it would not be as effective in stopping a train for the reason that the service application is much slower than the emergency, and for this reason an emergency application is much more effective than a full service application.

Q. If three cars which are cut out are placed together in the train, will the cut-out cars prevent an emergency application of the brakes beyond?

A. Two or three cars with brakes cut out will not prevent the triple valves on the following cars from operating in quick action.

Q. In what manner does the improved New York style "S" quick action triple valve differ from the old type triple valve commonly used on freight equipment?

A. It is a larger valve and has a larger graduating port for the air to pass to the brake cylinder; it also has a larger exhaust port, and the graduating valve is mounted on top of the exhaust valve.

Q. What advantage is gained by placing the graduating valve QT 163 on top of the exhaust valve?

A. It reduces the friction of the moving parts when the triple piston begins to move. The graduating valve moves first to uncover the service ports in the exhaust valve; then the exhaust valve is moved until the graduating valves in the exhaust valve and its seat register with each other.

Q. If the graduating valve QT 163 in the style "S" triple leaks, how can it be detected?

A. By making a partial reduction and then noting whether the brake releases of its own accord.

Q. If the graduating valve of this triple leaks, will it allow auxiliary pressure to escape through the exhaust port while in release position?

A. A leak of this kind will not allow the auxiliary pressure to escape through the exhaust port while the exhaust valve is in release position, for in this position it closes the opening from the auxiliary reservoir to the brake cylinder and atmosphere.

Q. How can this style of triple be distinguished from freight and 10-inch passenger triple valves?

A. The letter "S" is cast on the triple valve and the triple is fastened to the brake cylinder with three studs.

Q. What would be the result if cap nut QT 141 is not securely tightened?

A. If the cap nut is not securely fastened it will allow auxiliary reservoir pressure to leak away the same as it would with the release valve slightly open, and if the amount of leakage is large enough it will cause the brakes to release.

Q. If the check valve leaks or cap nut QT 119 is not securely tightened, what effect will it have on the brakes?

A. It will allow all brake cylinder air to leak away the same as with a leaky piston packing leather.

Q. When there is a constant flow of air from port J in the side of the triple valve, what is the probable cause?

A. The blow at port J indicates that the vent valve is leaking. This defect is sometimes accompanied by a blow at the triple exhaust valve, which indicates that the quick action or emergency valve is also leaking. If it is the vent valve which leaks, it would be indicated by the application of the brake when the cut-out cock in the cross-over pipe is closed, but if it is the emergency valve which leaks, the brakes will not apply with the closing of the cut-out cock.

Q. If it is difficult to maintain normal brake pipe pressure and the brakes fail to release properly, what does it indicate?

A. It indicates a bad leak in the brake pipe. The hose and connections of the brake pipe should be carefully examined, and it should be noted whether or not there is a blow at port J of the triple valve.

Q. If there is a leak at port J, where does the air come from?

A. The leakage would come direct from the brake pipe, due to vent valve QT 131 not being properly seated or the rubber seat being defective.

Q. If the brake applies in quick action during a service reduction, what is the probable cause?

A. It may be due to the packing rings in vent piston QT 129 fitting the cylinder too tightly, a weak vent valve spring, or small port F in the vent valve piston being stopped up.

Q. If the emergency action will not take place when a sudden, heavy reduction is made, what is the probable cause?

A. The packing ring of vent valve piston QT 129 may be worn or fitting poorly.

Q. What defects will cause a blow at the triple exhaust port?

A. A blow at this port may be due to leaky exhaust valve QT 138, leaky graduating valve QT 48, a defective gasket between the body of the triple valve and the brake cylinder head with passenger equipment, a defective gasket between the auxiliary reservoir and triple with freight equipment, or a leak in the auxiliary tube leading from the triple valve to the brake cylinder.

Q. What will be the effect of a leaky exhaust valve?

A. A leaky exhaust valve will cause a blow at the exhaust port whether the brake is applied or released, and when applied it will cause the brake to release.

Q. What will be the effect of a leaky graduating valve with the triple valve in lap position?

A. It will allow the auxiliary pressure to escape under the graduating valve and through the port into

the brake cylinder, reducing the auxiliary pressure and setting the brake with greater force. If the piston packing ring is in good condition, the auxiliary reservoir will continue to feed by the defective graduating valve until a sufficient difference in pressure exists between the brake pipe and the auxiliary reservoir to start the exhaust valve, when it may move to release position and release the brake.

Q. What will be the effect if the piston packing rings on this type of triple leak?

A. If the packing rings are defective and are leak-into the auxiliary reservoir as fast as the air leaks by the graduating valve into the brake cylinder, the brake will continue to set until the pressures are equal.

Q. What are the usual causes of the brakes failing to apply when the proper reduction has been made?

A. It may be due to feed grooves or strainer being stopped up, preventing the auxiliary reservoirs from charging, or the triple valve may be in a dirty condition, in which case the brake will not apply with a service reduction, but if a heavy reduction is made, the triple valve will be forced loose and will probably work satisfactorily during the remainder of the trip.

Q. What is the usual cause of this triple valve going into quick action when a service reduction is made?

A. The usual cause is that the triple does not respond to the first and sometimes the second service reduction, and the brake will not apply until the difference between the auxiliary reservoir and brake pipe pressure is sufficient to cause the triple piston to start from its stuck position and move forward quickly to emergency position, the stem striking sufficiently hard

to compress spring QT 132, causing vent valve QT 131 to open, which will cause a quick application of the brakes.

Q. How can a defective triple of this type be located?

A. It can be located by making sectional tests in the same manner as with the Westinghouse triple valves.

Q. Why is the New York high speed reducing valve called a compensating valve?

A. It is called a compensating valve for the reason that while operating in service application it acts as an ordinary safety or pressure reducing valve, while in an emergency application it holds the maximum cylinder pressure for a limited time before a reduction in pressure takes place.

Q. What is the duty of the non-return check valve HS 83?

A. In emergency application, the air which is vented from the brake pipe into the spring box HS 76 passes non-return check valve HS 83, which then seats and prevents the air which is entrapped in the spring box from escaping, except that it can pass out slowly through the small port drilled through the check valve.

Q. Describe the operation of the compensating valve style "A."

A. When an emergency application is made, a portion of the brake pipe air is vented at the side cap of the quick action triple valve, and passes through the pipe leading to the non-return check valve and spring box chamber, charging the spring box chamber under the piston. This pressure re-enforces the regulating spring pressure under the piston and permits

a full equalization of pressures from the auxiliary reservoir to be had and retained for several seconds before piston HS 77 can descend and upon the relief ports. When the air pressure in the spring box chamber has been reduced sufficiently below brake cylinder pressure, through the small port in the non-return check valve HS 33, the piston will be forced downward, and the relief ports controlled by the packing rings HS 81 will be opened and the brake cylinder pressure will gradually be reduced to the point of adjustment of the valve.

Q. How does the compensating valve operate in service application?

A. In service application, no air is vented into the spring box chamber; the only pressure which the piston has to overcome is that of regulating spring HS 11; consequently when the pressure in the brake cylinder is sufficient to overcome the tension of the regulating spring, the piston will be forced downward, promptly opening the relief ports.

Q. Why is it important that all joints surrounding the spring box air chamber should be kept air tight?

A. In order that the air which is entrapped in the spring box chamber by the non-return check valve HS 83 can find no means of escape except through the small port in the check valve which regulates the escape of air.

Q. What is the duty of the upper piston packing ring HS 81?

A. The purpose of piston packing ring HS 81 is to form an air tight joint in the cylinder, preventing brake pipe pressure from leaking past the piston into

the spring box chamber, and it also closes the relief port when in normal position.

Q. What are the functions of the lower ports which are controlled by the lower packing ring?

A. The lower ports controlled by the lower packing rings are leakage ports, and their function is to carry to the atmosphere whatever pressure may leak by the upper packing ring HS 81, thus preventing any leakage in the spring box chamber which would tend to balance the piston and retard the escape of air from the brake cylinder.

Q. What is the purpose of the lower packing ring in piston HS 77?

A. When this piston is in normal position, the lower packing ring HS 81 covers the leakage ports and prevents the spring box air from leaking past this ring to the atmosphere in emergency application. When piston HS 77 has moved to the lower end of its stroke, and the leakage ports to the upper and lower packing rings are about midway between the two rings, it is evident that any leakage by the upper packing ring will pass out through these ports.

Q. What is the advantage of holding the maximum cylinder pressure obtained from a pressure of 110 pounds in an emergency application?

A. The advantage is that an emergency application is more effective in retarding the motion of the train at high speeds, the maximum cylinder pressure being retained until the speed of the train has been reduced.

Q. Are there other advantages to be had with the use of high speed pressure?

A. There are other advantages, such as having the use of air for two or three service applications without recharging the auxiliary reservoir.

Q. Will the rate of reduction in brake cylinder pressure be about the same when the compensating valve is used on a 16-inch as on a 10-inch cylinder?

A. The reduction will be practically the same.

Q. At what pressure is the compensating valve usually adjusted to?

A. About 60 pounds, although for cars which have not standard brake gear, the adjustment sometimes varies from this amount.

Q. What defects is the New York train air signal system subjected to which differ from those of the Westinghouse train air signal system?

A. The defects of the New York train air signal are practically the same as those of the Westinghouse system. The same remedies for defects will apply to both signal systems.

EXAMINATION QUESTIONS—BLOCK AND INTERLOCKING SIGNALS AND RULES. ANSWERS TO BE WRITTEN IN THE SPACE MARKED "A."

Q. What is a block?

A.

Q. What is a block station?

A.

Q. What is a block signal?

A.

Q. What is a home block signal?

A.

Q. What is a distant block signal?

A.

Q. What is an advance block signal?

A.

Q. What is a block system?

A.

Q. What is a telegraph block signal?

A.

Q. What is a controlled manual block system?

A.

Q. What is an automatic block system?

A.

DESCRIPTION AND INDICATIONS OF BLOCK SIGNALS.

Q. What is an absolute block system?

A.

Q. What is a permissive block signal?

A.

Q. Describe a home block signal.

A.

Q. What is the color of the arms?

A.

Q. What is the governing arm of a block signal?

A.

Q. What are the normal and stop indications?

A.

Q. What is the "clear" indication?

A.

Q. What is the "caution" indication?

A.

Q. Under what condition is the "caution" indication used as a permissive signal?

A.

Q. Describe a distant block signal?

A.

Q. What does a "clear distant block signal indicate?

A.

RULES.

Q. Are block signal rules independent of the general rules governing train movements and the movements directed by train orders?

A.

Q. Does the block system in any way relieve the trainmen from flagging in accordance with the general rules?

A.

Q. Are block signals used for any other purpose than blocking trains?

A.

Q. What is the normal indication of all home block signals?

A.

Q. What is the normal indication of distant block signals?

A.

Q. When there are no distant signals when should an operator change the home block signal from normal indication to either "clear" or "caution" indication?

A.

Q. On single track lines should both arms or both lights of the home block signal display "clear" or "caution" indication at the same time?

A.

Q. When should a home block signal be restored to the "stop" indication after having been changed for a train that stops?

A.

Q. When should it be restored to "stop" after being changed for a train that does not stop?

A.

Q. Should clearance cards be used for trains to go beyond the 1,000 foot limit without first arranging for the block in the usual manner?

A.

Q. Should trains of inferior rights take sidings a sufficient time in advance to avoid blocking first-class and other important trains following?

A.

Q. What is required of a conductor before a train can leave a double track for a single track, or to enter on to the main line from a branch line?

A.

Q. After taking a siding to be passed by a following train, what is required before again occupying the main track?

A.

RULES—PERMISSIVE BLOCK.

Q. By what authority may two or more trains running in the same direction, be allowed in the same block at the same time?

A.

Q. Will any train be permitted to enter a block occupied by a passenger train preceding it in the same direction?

A.

Q. Should a passenger train be allowed to enter a block occupied by another train moving in the same direction?

A.

Q. At block stations where the permissive or three position block signal is used, what will the conductor and enginemen do upon finding the signal displayed at "caution?"

A.

Q. Approaching stations where the absolute or two position block signal is used, with the signal dis-

played at "stop," what is required before the train can proceed?

A.

Q. How should trains proceed after entering a block under a "caution" signal or on receipt of a permissive card?

A.

Q. In the event of a collision under such conditions, who will be held responsible?

A.

Q. Should the conductor and enginemen each have a copy of the permissive card?

A.

SIGNALS—AT INTERLOCKING PLANTS.

Q. What style of signals are used at interlocking plants?

A.

Q. What governs the movement of trains at interlocking plants by day? What governs them by night?

Q. What do the positions and shapes of the arms or color of the lights displayed, indicate?

A.

Q. Which arm, right or left, governs the movement of an approaching train?

A.

Q. Name the three different kinds of interlocking signals?

A.

Q. When home signals have more than one arm, what are they called?

A.

Q. What is the shape and color of a home signal?

A.

Q. Where is a single arm home signal used?

A.

Q. How is stop indicated by day? By night?

A.

Q. How is "clear"or "proceed" indicated by day? By night?

A.

Q. In connection with what movement is a single arm home signal used?

A.

Q. Where is a double arm home signal used?

A.

Q. What route does the upper arm govern?

A.

Q. How is "clear" indicated by the upper arm by day? By night?

A.

Q. What route does the lower arm govern?

A.

Q. How is "clear" indicated by the lower arm by day? By night?

A.

Q. At junction points are the upper and lower arms and lights assigned to the routes they govern by bulletin or special notices?

A.

Q. What is the shape and color of a distant signal?

A.

Q. What does a distant signal indicate?

A.

Q. What is its location?

A.

Q. If the home signal has two arms, which one of them will the distant signal indicate?

A.

Q. How is "caution" indicated by the distant signal by day? By night?

A.

Q. What should be done when "proceed with caution" is indicated?

A.

Q. How is "clear" indicated by day? By night?

A.

Q. What is a dwarf or pot home signal?

A.

Q. What is it used for?

A.

Q. Are the positions of arms and the color of the lights the same and do they have the same meaning as those of the high home signal?

A.

Q. Under what conditions are the bracket signals used?

A.

Q. Can a bracket signal be used in connection with either a home or distant signal?

A.

Q. When a bracket signal is located to the right of the track, showing a semaphore arm in connection with one stub post, what track does the semaphore arm govern?

A.

Q. If the bracket has two stubs, what track does the semaphore govern?

A.

Q. Does the number of stub posts represent the number of tracks between the main post and the track that the semaphore arm governs?

A.

Q. When a bracket contains two semaphore arms, does the semaphore arm to the right govern the right hand track, and does each stub represent a track between the track governed by the right-hand semaphore and the one governed by the left-hand semaphore?

A.

Q. What is the color of the lights used on stub posts?

A.

LOCATION OF SIGNALS.

Q. What is the location of interlocking signals?

A.

Q. What is the exception?

A.

Q. What is the location of the home signal with reference to the derail it governs?

A.

Q. What is its location with reference to the interlocked crossings?

A.

Q. What is the location of the distant signal with reference to the home signal?

A.

Q. What is the location of a dwarf signal with reference to the derail it governs?

A.

INTERLOCKING PLANT—RULES.

Q. Unless otherwise provided for, does interlocking signals affect the rights of trains under time-table or train rules, or do they dispense with the use or observance of other signals whenever they may be required?

A.

Q. How should all trains approach interlocking plants?

A.

Q. Can a train or engine pass beyond a signal indicating "stop?"

A.

Q. If, after accepting a "clear" signal, it is changed to a "stop" signal before the train reaches the signal, what are the duties of the engine and train men?

A.

Q. To whom should such occurrences be reported?

A.

Q. Should "clear" hand signals be accepted as against fixed signals until you are fully satisfied with the conditions and know that you are protected?

A.

Q. When fixed signals are in operation, should "clear" hand signals be given or accepted?

A.

Q. If a train has parted on approaching an interlocking plant, what whistle signal must be given?

A.

Q. When an engineman receives a train parted signal from the signalman, what response must be made?

A.

Q. Should any unusual detention at interlocking plants be reported to the Train Master?

A.

Q. Should trains or engines that have stopped when making movements through interlocking plants, be moved in either direction until after having received a signal from the signalman?

A.

Q. Should flying switches be made over interlocking switches?

A.

Q. Should any train or portion of a train be allowed to stand within the stop signal limits for an unreasonable length of time?

A.

Q. What action should be taken in the absence of a fixed signal or a partially or imperfectly displayed signal?

A.

Q. Are all train movements at interlocking plants entirely under the control of the signalman?

A.

Q. What is the maximum speed allowed when making movements within the limits of an interlocking plant or when passing into a siding?

A.

Q. Should a signal be given for each train movement made within the limits of an interlocking plant?

A.

Q. What is the normal indication of home signals?

A.

Q. What is the normal indication of distant signals?

A.

TRAIN ORDER—EXAMINATION QUESTIONS

TO BE ANSWERED IN WRITING IN THE SPACE MARKED "A."

EXAMPLES.

Order No. 1. "No. 2, engine 500, will meet No. 1, engine 501, at 'C.'"

Q. What would you do if on No. 2? What would you do if on No. 1?

A.

Q. If No. 1 arrived carrying signals and you were on No. 2, what would you do?

A.

Order No. 2. "No. 2, engine 500 will take siding and will meet No. 1, engine 501 at 'B.'"

Q. What would you do if on No. 2?

A.

Q. What would you do if on No. 1?

A.

Order No. 3. "No. 1, engine 500 will meet 1st No. 22, engine 700 at 'B.' 2d No. 22, engine 507, at 'C,' and extra 715 at 'D.'"

Q. If on No. 1, what would you do?

A.

Q. If on 1st or 2d No. 22 or on extra 715, what would you do?

A.

Order No. 4. "No. 1, engine 500, will meet 2d No. 22, engine 705, at 'D' instead of 'C.'"

Q. If on No. 1, where would you meet 2d No. 22?

A.

Order No. 5. When No. 1 reaches "D" he receives the following order: "Order No. 3 is annulled."

Q. Where would No. 1 meet 2d No. 22?

A.

Q. What would No. 1 do with regard to extra 715?

A.

Order No. 6. "Passenger Special 450 east will meet extra 715 west at 'C.'"

Q. What would you do if on special 450?

A.

Q. What would you do if on extra 715?

A.

Order No. 7. "Order No. 6 is annulled."

Q. What would you do if on passenger special or extra?

A.

Order No. 8. "Extra 715 west will meet extra 720 east at 'D.'"

Q. Which train will take siding?

A.

Order No. 9. "Extra 715 east will pass No. 22, engine 700 at 'C.'"

Q. What would you do if on No. 22?

A.

Q. What would you do if on extra 715?

A.

Order No. 10. "Extra 715 will pass No. 22, engine 700, when overtaken."

Q. What would you do if on No. 22?

A.

Q. What would you do if on No. 715?

A.

Order No. 11. "Extra 715 east will run ahead of No. 22, engine 700, 'E' to 'B.'"

Q. What would you do if on extra 715?

A.

Q. What would you do if on No. 22?

A.

Order No. 12. "No. 42, engine 715, will pass 1st No. 22, engine 700, at 'D' and run ahead of No. 2, engine 500, 'D' to 'B.'"

Q. What would you do if on No. 42?

A.

Q. What would you do if on 1st No. 22?

A.

Q. What would you do if on No. 2?

A.

Q. Under order No. 12, should No. 2 exceed the speed of No. 42 between the designated points?

A.

Order No. 13. "No. 22, engine 700, has right over No. 1, engine 500, 'E' to 'B.'"

Q. What would you do if on No. 1?

A.

Q. What would you do if on No. 22?

A.

Q. What right does this order give No. 22 over No. 1 and how far?

A.

Q. Under what circumstances could No. 1 pass "B" and make stations "C" and "D" against No. 22?

A.

Q. If No. 22 should meet No. 1 between "E" and "B," which train must take siding?

A.

Q. What is the duty of the conductor of No. 1 if his train meets No. 22 at "C" or "D" or west of "E"?

A.

Order No. 14. "Extra 715 west has right over No. 22, engine 702, 'A' to 'D.'"

Q. What would you do if on No. 22?

A.

Order No. 15. (If Order No. 14 was modified to read as follows); "Extra 715 west has right over No. 22, engine 70 'A' to 'D' and will wait at A' until 8:15 a. m., 'B' until 8:30 a. m., 'C' until 9 a. m., for No. 22, engine 702."

Q. What would you do if on extra 715?

A.

Q. What would you do if on No. 22?

A.

Q. What time would you clear the schedule of extra 715 at "C," "B" and "A"?

A.

Order No. 16. "Work extra 715 has right over all trains between 'B' and 'D' from 1:30 p. m. to 5:30 p. m."

Q. What would you do if on the work extra?

A.

Q. What would you do if on any other train?

A.

Order No. 17. "Regular trains have right over No. 2, engine 450, between 'E' and 'A.'"

Q. What would you do if on No. 2?

A.

Q. What would you do if on other regular trains?

A.

Order No. 18. "No. 2, engine 450, will run thirty minutes late 'E' to 'B.'"

Q. If on No. 2 how would you run from "E" to "B"?

A.

Q. If on No. 2 would order No. 18 affect your schedule leaving time at "B"?

A.

Q. If on a west bound train would order No. 18 give you any right except time-card schedule between "A" and "B"?

A.

Q. If on a west bound train how would order No. 18 affect you between "B" and "E"?

A.

Order No. 19. "No. 2 will run fifty minutes late 'E' to 'D,' forty minutes late 'D' to 'C,' and thirty minutes late 'C' to 'A.'"

Q. If you were on No. 2 how much later than your schedule would you run "E" to "D?"

A.

Q. How much later than your schedule would you run from "D" to "C" and how much later from "C" to "A"?

A.

Q. What time would you leave "A"?

A.

Q. If on an opposing train how would you run with respect to the regular schedule of No. 2 from "A" to "C"?

A.

Q. How would you run from "C" to "D" and from "D" to "E"?

Order No. 20. "No. 2, engine 450, will wait at 'C' until 11:30 a. m., for No. 21, engine 730."

Q. If on No. 2 how long will you wait at "C"?

A.

Q. If on No. 21 what time must you clear the main track at "C"?

A.

Q. At what time must you clear the main track at "B" and "A"?

A.

Order No. 21. "Engines 688, 689 and 690 will run as 1st, 2d and 3d No. 21 'A' to 'E.'"

Q. Under this order which engines will display signals?

A.

Order No. 22. "Engine 688 is annulled as 1st No. 21 from 'C.' Following sections will change numbers accordingly."

Q. As what section would engine 689 leave "C"? Engine 690 leaving "C"?

A.

Order No. 23. "Engine 85 will display signals and run as 2d No. 1 'N' to 'Z.' Following sections change numbers accordingly."

Q. If you were on engine 85, what would you do?

A.

Q. If you were on a following section, what would you do?

A.

Order No. 24. "Eng. 85 is withdrawn as 2d No. 1 at 'H.' Following sections will change numbers accordingly."

Q. If you were on engine 85, what would you do?

A.

Order No. 25. "Eng. 18 instead of eng. 85 will display signals and run as 2d No. 1 'R' to 'Z.'"

Q. If you were on engine 85, what would you do?

A.

Q. If you were on engine 18 what would you do?

A.

Order No. 26. "2d No. 1 take down signals at 'D.'"

Q. If you were on 2d No. 1 what would you do?

A.

Q. If you were on a following section could you proceed beyond "D"?

A.

Order No. 27. "Engs. 99 and 25 will reverse positions as 2d and 3d No. 1 'H' to 'Z.'"

Q. What will you do if on engine 99?

A.

Q. If on engine 25 what will you do?

A.

Q. Under this order will it be necessary to change signals?

A.

Order No. 28. "Eng. 369 will run extra 'A' to 'E.'"

Q. How would you run with respect to scheduled trains?

A.

Q. How would you run with respect to other extra trains?

A.

Q. If you received this order at a non-register station what precaution must be taken before starting?

A.

Order No. 29. "Eng 500 will run extra 'A' to 'C' and return to 'B.'"

Q. How would you run with respect to regular trains?

A.

Q. If you should receive this order at a non-register station what precaution must be taken before starting?

A.

Order No. 30. "Eng. 450 will run extra, leaving 'A' on Thursday, Feb. 17th, as follows, with right over all trains:

	"A"	*11:30 p. m.*
	"B"	*11:55 p. m.*
	"C"	*12:15 p. m.*
Arrive	*"D"*	*1:05 a. m.*

Q. If you received this order how would you run with respect to other trains?

A.

Q. If you were on a 1st, 2d, 3d or an inferior class train and received this order, how would you run with respect to engine 450?

A.

Q. What is your understanding as to clearing the schedule of engine 450?

A.

Q. Can this form of an order be given specifying the right over only certain trains or certain classes of trains?

A.

Order No. 31. "Eng. 292 works 7 a. m. to 6 p. m. between 'D' and 'E.'"

Q. With this order what would you do with respect to regulaı trains?

A.

Order No. 32. "Work extra 232 will run 'A' to 'B' and work 7 a. m. to 6 p. m. between 'B' and 'C.'"

Q. With this order what would you do with respect to regular trains?

A.

Order No. 33. "Work extra 292 will work 7 a. m. to 6 p. m. between 'B' and 'C' and will keep clear of extra 230 west after 2 p. m."

Q. If you were on work extra 292 what would you do?

A.

Q. If on extra 230 what would you do with respect to this order?

A.

Order No. 34. "Work extra 292 will work 7 a. m. to 6 p. m. between 'B' and 'C,' protecting itself."

Q. With order No. 34 are you expected to protect against all trains or only regular trains?

A.

Order No. 35. "Extra 230 will protect against work extra 292 between 'B' and 'C.'

Q. If on extra 230, what would you do?

A.

Q. Are work trains required to allow extra trains to pass when met or overtaken?

A.

Q. Do you understand that when an extra is given orders to run over working limits, that it must at the same time be given a copy of the order sent to the work train?

A.

Order No. 36. "Hold No. 2, eng. 500, at 'D.'"

Q. To whom must this order be addressed?

A.

Q. How must it be acknowledged?

A.

Q. How must it be respected by conductors and enginemen?

A.

Q. When a train is so held, what is required before the train can proceed?

A.

Q. Do you understand that this order will only be used when necessary to hold trains until orders can be given or in case of emergency?

A.

Order No. 37. "No. 96 of April 10th is annulled 'A' to 'H.'"

Q. How does the above order affect No. 96?

A.

Q. Can No. 96 of that date be restored between the points named under its original number?

A.

Order No. 38. "Train No. 22, due to leave 'C' Monday, March 6th, is annulled 'C' to 'A.'"

Q. Under order No. 38 if you were on a westbound train how would you regard train No. 22 between "A" and "C"?

A.

Q. How would you regard No. 22 between "C" and "E"?

A.

Order No. 39. "Order No. 32 is annulled."

Q. Can an order that has been annulled be reissued under its original number?

A.

Order No. 40. "That part of Order No. 3 reading No. 1, eng. 500, will meet extra 715 east at 'D' is annulled."

Q. If on No. 1, what would you do?

A.

Q. If on extra 715, what would you do?

A.

Q. How does this order affect the balance of order No. 3?

A.

Q. Can any order or part of an order that has been superseded be reissued under its original number?

A.

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